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CURRENT SCIENCE

Vol. V] February 1937 [No. 8

CONTENTS.

The Indian Institute of Science—II.

IN the editorial published in the last number of this Journal, we endeavoured to provide our readers with a historical background of the evolution of the Indian Institute of Science, which, however meagre, was considered necessary for a proper appreciation of the principal recommendations of the Irvine Committee. We felt that, without such a perspective, the general public might place undue emphasis on the critical and exciting observations on "the circumstances of the Institute" which thickly mantle the more important and fundamental sections of the Report. Reperusing the Committee's report we are led to form the opinion that the Irvine Committee have presented a document which really embodies the results of investigation belonging to two unrelated committees, *viz.*, The Enquiry Committee and the Reviewing Committee. This fact gives it all the piquancy of interest which the publication of the Report has stimulated in the public mind.

The more we read this interesting document, the deeper is our conviction that the Committee did not strictly adhere to the terms of reference to them, *viz.*,

> "To review the working of the Institute with special reference to the purposes for which it was founded and, if any changes are considered desirable in the organisation or activities of the Institute for the better achievement of these purposes, to make recommendation accordingly, but with due regard to the Institute's actual or reasonably augmentable financial resources."

If the Irvine Committee had treated the Institute from an impersonal standpoint, and had only confined their investigations to matters relating to the equipment of the laboratories, departmental researches, their general interest to pure and applied science,

their scope and direction of expansion, competence of the personnel and other academic and financial problems, their report would have been an invaluable contribution. Whether the reflections on other subjects included in the report lend additional weight and value to the scheme outlined by the Committee is doubtful.

We propose briefly to review the critical and constructive sections of the Committee's Report.

The "circumstances," whatever their nature and extent, which prevailed in the Institute immediately preceding the assembly of the Committee, and which, in our opinion, the Governing Council by virtue of their inherent powers should have controlled, without passively exposing their cumulative effect to the serious comments of an external body, must be at least partly due to efforts at introducing internal reforms and re-adjustments; and their very ephemeral character must render them too insecure a foundation for basing permanent and far-reaching proposals for the advancement of the academic interests of the Institute. That the "atmosphere" and "circumstance" of the Institute greatly influenced the judgment of the Committee is manifest from their remark that "in the present circumstances our recommendations become the more emphatic in order that the Institute may be saved from disintegration." If the recommendations have really such vitality as to preserve the Institute from putrefaction, then the high note of confidence expressed by the Committee is irreconcilable with the somewhat pessimistic key of the concluding sentence of the report, *viz.*, "if our scheme fails, it can only be through the clash of personalities beyond the remedy of any powers possessed by a Reviewing Committee." This spirit of diffidence should be foreign to recommendations based absolutely on the stern academic demands of the Institute.

The report makes certain observations which, not based on facts, unfortunately tend to weaken the effectiveness of the general recommendations. We shall deal with a few of them.

In their Proposals for economising the financial resources, the Committee observe that

"The hostels would be more economically managed if the post of the Warden were abolished, and the students took into their hands the control of messing arrangements under the general supervision of one of the senior resident members of the staff."

The Sewell Committee writing on the same subject deplored that

"The post of the Hostel Warden being left vacant was subsequently abolished."

The fact is the post has been non-existent for several years.

The main thesis of the report which is really of some importance, is that the Institute has from the beginning devoted all its resources and energies towards developing purely theoretical investigations, and has practically ignored its capacity for lending effective assistance to the advancement of industries. To readers of the Irvine Committee Report, who have no access to relevant literature, the remark that

"applied research has been handicapped from the beginning because no organised contract exists between the Institute and the world of industry."

must necessarily give an erroneous and misleading impression, for the industries in India have not developed in a measure comparable with those of the Western countries, and further, repeated references to them by the authorities of the Institute have elicited the reply that there were few scientific problems encountered by them for solution. However, few will dispute the desirability of such a contact, but all may not agree that the want of it imposes a handicap. We have to remember that so long as the primary function of the Institute is to train students in methods of research, the subjects selected should necessarily have an instructional value. It seems to us that while keeping this function in the foreground, the authorities of the Institute have also borne in mind the possible application of the results of such an enquiry to the inception of new industries and the improvement of the existing ones. In a booklet published in 1924 when the Indian Science Congress held its Eleventh Annual Session in Bangalore, Sir Martin Forster has recounted in detail the principal activities of the Institute in the field of applied science, and these achievements form an impressive record. The list is too big to be transcribed here. Within the last few years as the result of experimental work conducted at

the Institute, The Porcelain Factory has come into existence. It is true that spectacular results revolutionising industrial methods have not been produced by the Institute, and it is extremely doubtful whether they would have been achieved, even if an intimate contact with the world of industry had been established. If India should become a competitor with other Western countries as the producer of industrial goods, and if she is to achieve economic independence, the greatest need is to encourage and promote fundamental research and there should be one foundation entrusted with the responsibility of prosecuting and directing academic enquiries, and at the same time should be able and willing to undertake investigations of problems in applied science initiated by its professors or referred to them by industrial bodies.

Another instance of a statement not founded on facts is the allegation that, "The reduction in the allotments for the other departments has seriously curtailed their activities" and it is suggested that this state of affairs has resulted from "the Director's policy to make the Institute a centre of physical and mathematical studies." In expressing disapproval of this policy the Committee point out that these subjects offer an attractive field for speculation and experiment and have no direct contact with industry. There are three elements in this criticism. Regarding the bearing of academic researches on the development of industries, Professor M. N. Saha is reported to have said in his recent address at Hyderabad that,

> "In this country the criticism is being made that the Universities were doing only academic work. If they neglected this work (Physics) for industrial research, they would be neglecting their duties, the effect of which will be seen in the falling of the standard and efficiency in the industrial work itself."

The Irvine Committee make the suggestion that

> "The creation of the new department of Physics at the time when the financial resources of the Institute were diminishing, has had the inevitable effect of withdrawing from the other departments a certain proportion of the allotments that had hitherto been available for them". Thus "the reduction in the allotments for the other departments has seriously curtailed their activities."

We have examined the annual reports of the Institute with a view to discover the truth of this serious criticism, and we are afraid that with the information we have been able to collect from these authoritative publications, we cannot agree with the observations of the Committee. In the first place, the Committee in Part III of their Report, have taken the actual expenditure for 1934–35 for comparison with the revised budget for 1935–36, and the disparity in figures should be accounted for by circumstances such as the late appointment of certain professors and the failure of others joining their posts, internal transfers, the proceeding of a few to appointments elsewhere and the general cutting down of grants owing to financial stringency. Even assuming that it is permissible to compare the actuals of one year with the revised estimates of the succeeding year, then according to the figures quoted by the Committee, the Departments of Electrical Technology and General and Organic Chemistry have suffered to the extent of Rs. 1,08,510 and the gain on the part of the department of Physics is Rs. 33,842. If this amount is distributed among the three oldest departments which have been building up their equipment and receiving increments to their staff for over twenty years, then each department would have contributed 10 per cent. of its allotment for assisting the newly created Physics department to provide itself with the necessary apparatus and staff. The spirit of mutual co-operation in times of financial depression is commendable. Further even supposing that the three departments should not have been deprived of the small percentage of their grants, has this rendering of help "seriously curtailed their activities"? We give below the number of publications issued by each department for the five years covered by the Irvine Committee Report.

	30-31	31-32	32-33	33-34	34-35
1. Electrical Technology ..	1	2	7	1	15
2. General Chemistry ..	7	2	2	7	10
3. Organic Chemistry ..	10	6	11	7	14
4. Biochemistry ..	25	11	12	33	49
5. Physics ..	..	..	..	..	39

The year in which the withdrawals of allotments from other departments are seriously animadverted upon by the Committee happens to be one of unprecedented activity in each department. This creditable and remarkable output of work from

the other departments must be due to the spirit of emulation created by the newly founded department of Physics.

We shall now deal with some of the more important recommendations of the Committee.

The essential part of the re-organisation proposed by the Committee is the appointment of a Registrar whose duties have been indicated in clear terms. The Pope and Sewell Committees recognised the need of the appointment of a Registrar, and made suitable recommendations, but so long as the Director was not also the head of a Department, the appointment was deferred. As the present Director is entrusted with the responsibilities of developing a new department which must necessarily absorb all his time and energy, any measure for relieving him of the routine office duties must be welcome to him. The Committee emphasise that the responsibilities of the Registrar "can be carried out only by a man of mature experience, trained in the official administration." We fail to see the importance of the stress laid on administrative experience, for the previous Directors who were carrying on administrative duties with conspicuous ability were eminent laboratory experts, and we are of opinion that a man possessing an intimate knowledge of the scientific activities in general and of the state of scientific advancement in India in particular, together with an acquaintance with research work carried on in technological and industrial Institutions, would be better qualified not only to deal intelligently with all the scientific matters pertaining to the Indian Institute, but also "to restore harmony in the administration and a feeling of confidence in the staff". We further feel that a most suitable candidate for this post could have been secured, if the Governing Council had been permitted to act in accordance with the Regulations governing the appointment of superior officers, without the Committee invoking the direct intervention of the Government of India.

One of the outstanding academic reforms suggested by the Committee which, in their opinion, would come nearest to fulfilling the intentions of the Founder of the Institute is the creation of "a strong representative school of Chemistry capable of playing a significant part in pure and applied researches" with Chairs in five divisions of the department. The head of this new department of Pure and Applied Chemistry—the synthesised product of the existing General and Organic Chemistry departments,—is to be an Organic Chemist "of recognised eminence, acquainted with and interested in the technical applications of Chemistry", directing researches in organic chemistry, physical chemistry, inorganic and mineral chemistry, technical chemistry and pharmacological and medicinal chemistry, and receiving a maximum salary of Rs. 2,000 from the commencement of his service. A proposal of this magnitude and impracticability has been accepted with its financial obligations by the Governing Council, and approved by the Government of India. In order to provide for the appointment of the head of the new department and for five assistant professors, each on a salary of Rs. 800, the Irvine Committee have proposed a revised draft budget based on their proposals of effecting economies. Any one perusing the figures of this budget, on the basis of which the future budgets of the Institute are likely to be prepared, would be tempted to quote the very sentence of the Committee with very slight alteration, "the creation of the new department of Pure and Applied Chemistry at a time when the financial resources of the Institute were diminishing has the inevitable effect of withdrawing from the other departments a large proportion of the allotment that had hitherto been available for them". In making proposals for the re-organisation of the Chemistry Department, the Committee could not have remembered their criticism of the Physics Department to which they have unwittingly exposed themselves. We feel diffident about the practicability of the new scheme, and we would prefer the existing departments to retain their individual existence with professors at the head of each department. In order to defray the cost of their proposals of administrative re-organisation and academical reform, the Committee have formulated certain measures of economies which seem to us singularly unfortunate. These measures include suspensions, abolitions and replacement of posts and reductions of emoluments under eight categories. Out of the savings thus effected the appointment of a Registrar, a Professor of Organic

Chemistry and five Assistant Professors is to be financed. The Committee may have succeeded in framing a balanced budget, but are the authorities of the Institute also sure that the means suggested towards that end will secure contentment, harmony and cheerful co-operation among the members of staff affected by retrenchment? A casual perusal of the annual reports of the Institute will convince any reader that the contributions made by the senior assistants are quite as voluminous and valuable as those made by the Professors. They occupy positions of trust and responsibility in the department. The sudden change of their official designation and the drastic reduction in their remuneration by more than forty-four per cent. must tell adversely on the efficiency of the departments, and after all, the harder part of the departmental activities must ultimately devolve on the senior assistants, all of whom are entrusted with the duty of instructing the students and training them in the methods of research. The suggestion of reducing the provision for travelling expenses will undoubtedly diminish the opportunuties of the Director establishing contact with the industrial research centres, and prevent the Professors and other members from attending scientific conferences. The Pope and Sewell Committees have emphasised the importance and necessity of the Director touring in India for the purpose of securing co-ordination of the work of the Institute with that of the official and semi-official research institutions and of disseminating information concerning the activities of the Institute, and the Professors and their assistants would, by attending the periodic scientific gatherings and industrial conferences, expound, as part of their legitimate duty, their own researches and receive information regarding the lines along which co-operation could be established. The proposal of reduction in expenses under printing and stationery must unfavourably react on the size and number of instalments of the Journal, which is at present the only organ announcing to the world of science the important results obtained in the scientific departments of the Institute, but the Committee is apparently not disturbed even if there is a fall in the number of publications, for they observe "few publications are likely to result from such (industrial) research work, but this need not be deplored".

We have pursued a line of thought not quite in conformity with that of the Irvine Committee in framing their scheme, but that does not diminish our warm and sincere appreciation of the candour and forcefulness with which they have urged their recommendations. It must be remembered that the situation which confronted them rendered their task both delicate and difficult, and none could have achieved the work more thoroughly or more enthusiastically.

The phrase "the benefit of India" occurring in the Scheme for the Administration of the Institute connotes a deeper significance to us than merely material welfare of India. The greatest benefit that the Indian Institute of Science can confer on India is, in the first instance, to preserve peace, harmony and trustful co-operation among the members of staff and students, which according to the Irvine Committee Report were almost on the verge of extinction, and in the second place the members of staff should be an inspiring example to the students of those qualities which distinguished Michael Farady and Louis Pasteur. If Science is synonymous with Truth, then the Indian Institute of Science should be the greatest and most responsible official expositor of Truth. In a recent address which Sir Venkata Raman gave at the Prize Distribution Ceremony of a local educational institution, he is reported to have observed that

> "the true wealth of the Nation was in the rising generation. Their character, their cheerfulness and the courage with which they assayed the task of life depended very much on the kind of training they received and, surely, producing this human wealth was a great industry."

Sir Venkata Raman's stewardship of the Institute will be finally judged by the care and assiduity with which he fosters this "industry" and by the zeal and sincerity with which he inculcates the sanctity of "character" in the minds of the young men who pass through his hands.

The Irvine Committee have produced a report embodying the results of patient investigation, some of whose recommendations are bound to be puzzling, while a few others must necessarily be in conflict with those of their predecessors, obviously because the Committees did not pursue a continuous policy, and did not develop a coordinated unitary scheme.

The Institute is now favoured with a large number of authoritative reports, each defining its aims and objects and each proposing recommendations for its improvement independently of the other. We have read these reports and all the available relevant literature, and we cannot resist the conclusion that all these documents should be carefully studied by a special section of the Governing Council which, working in a peaceful atmosphere, could evolve a more practical scheme for the academic administration of this great foundation, inaugurating a ten-year plan of development, as far as possible in conformity with the spirit of the recommendations of the previous committees.

Our proposal to subject all the reports for a general and comprehensive review by a Sub-Committee of the Council is to enable the authorities to discover the greatest common measure of agreement underlying the recommendations of the reviewing and special committees, which should form the basis of the scientific policy of the Institute for the next ten years. In close collaboration with the heads of different departments, and in consultation with the external bodies suggested by the Irvine Committee, this Sub-Committee ought to be able to draw up a programme of laboratory work for the same period, without in any way curtailing the freedom of the professors to initiate new lines of research or to prosecute and direct those now in progress. If the intention of the Government of India in appointing a reviewing committee is not to permit the recommendations of this body to rescind those of the previous committees, then it is obvious that a harmonious synthesis of the best and the most acceptable sections of all the reports may prove a fruitful field on which the Institute may profitably expend its money and labour. The divergence in the view-point as well the strongly-held antithetical recommendations of the different committees must be a sufficient justification for the proposal we have made, and the opinions expressed by them regarding the economies to be practised by the Institute, the reorganisation of the chemistry departments, the establishment of competent professorial chairs and the allocation of duties to the Registrar, differ so fundamentally, that further and more comprehensive examination of all the various schemes may be necessary and desirable before practical steps are taken to implement any set of recommendations. The important problem of augmenting the financial resources of the Institute has not been seriously discussed in any Report, and the equally important question whether the Universities, which enjoy the privilege of returning a representative to the Council, are not to be invited to contribute an annual grant to the Institute, and whether in recognition of such contribution these academic institutions are not also to enjoy the privilege of selecting their best scholars for further work in the different departments, must engage the consideration of the Sub-Committee. The feasibility of this scheme, which in our opinion will tend to establish a more sympathetic and closer co-operation between the Institute and the Universities, so desirable in the general interest of the progress of science in India, depends almost entirely upon the confidence which the Universities have that "the Institute would do what no other Institution can do". Such confidence and co-operation entail "that the chairs in the Institute should be filled by men of the highest eminence, irrespective of nationality" and for this purpose the Sewell Committee recommended that the terms of appointment to the Directorate and Professoriate be made sufficiently favourable to attract such men.

We have not the least hesitation in thinking that the essence of the Irvine Committee Report is that the Institute must be ethically pure and scientifically great, and we emphasise that the need and responsibility of upholding the moral purity of this great foundation are even greater than promoting its academic achievements.

The Silver Jubilee of H. E. H. The Nizam.

WITH a fortnight of rejoicing Hyderabad is celebrating the Silver Jubilee of the reign of her ruler, His Exalted Highness Sir Osman Ali Khan Bahadur.

The changes that have come over the State of Hyderabad since the present ruler assumed the reins of government are at once important and far-reaching. Ethnically and otherwise the Dominion of the Nizam was a singular composite of elements varying greatly and differing in certain respects from other native states, when His Exalted Highness ascended the throne. The Nizam, who recognized early enough the advantages accruing to his state from direct personal administration, effected radical changes in the then-existing form of government. The discriminating judgment exercised by the Nizam in the choice of statesmen like the Right Hon'ble Sir Akbar Hydari to fill positions of trust and responsibility, has been an invaluable asset to the State, and Hyderabad to-day holds the proud and unique record, that the great depression, which affected nearly every country in the world, was powerless, against the superior devices of her statesmen, to check the tide of her swelling revenues.

Foremost among his peers of the Princely Order in India, both as a sagacious administrator and as an experienced statesman, the interests of his subjects have ever been nearest the Nizam's heart. During the past quarter of a century of his rule the most notable improvements in the State have always had a direct bearing on the economic and social amelioration of his subjects. The Nizam who is well known for his ascetic simplicity, severely whittled down all expenditure connected with the pageantry of the Jubilee, and has recommended, that the funds should be used for schemes of rural uplift and provision of health clinics. The foundation of the Osmania University, on the lines of the most advanced educational centres of the West, is but one instance of the zeal of His Exalted Highness to further the cause of higher education in the State. The interests of the ryots have not been neglected in this multi-phased progress. Numerous irrigation projects are being undertaken and the translation into action of the faith that can move a mountain has culminated in the impounding of river water at Hussiensagar. Amidst this rapid advance in the material welfare of the people of Hyderabad, the Nizam has not lost sight of their spiritual betterment and the religious rituals form the most important part of the Jubilee festivities.

It can scarcely be otherwise than appropriate to recall here the solemn pledge given by the Nizam on the eve of his accession—"It is my highest ambition to be in all respects, both to the Government of India and to my own people what my late father was; a friend on the one hand and a beneficent ruler on the other." To what extent he has redeemed this pledge the present State of Hyderabad bears eloquent testimony.

Studies on Polyploid Plants.

Triticum-Haynaldia Hybrids with Special Reference to the Amphidiploids *Triticum dicoccum* × *Haynaldia villosa*.

By D. Kostoff and N. Arutiunova.

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GENUS *Haynaldia* has been used for intergeneric hybridization with the genus *Triticum* by several investigators. Hybrids have been produced with representatives of *vulgare*—and of *durum*—group, all being highly self-sterile. The hybrids set seeds very rarely when flowering free in the field, but somewhat more when pollinated with a third species or with the *Triticum* parent. Tschermack[1] (1929), however, obtained in the subsequent generations a fully fertile hybrid from the cross *Tr. turgidum* ($2n = 28$) × *Haynaldia villosa* ($2n = 14$). The cytological studies of this hybrid showed that it is an amphidiploid plant with 56 somatic chromosomes[2] (Berg, 1934).

During the last few years we crossed and studied a series of double and triple hybrids, as well as allopolyploids produced in crossing *Triticum* species with *Haynaldia villosa*. We produced a large number of F_1 — *Tr. dicoccum* × *Haynaldia villosa*, and several plants of the cross combination *Tr. vulgare* (Novinka) × *Haynaldia villosa*. The majority of the spikes of these hybrids bloom free, while some of them were crossed back to the parental species or pollinated with pollen from a third species. From the seeds thus obtained we grew two plants in 1935 and fifteen plants in 1936.

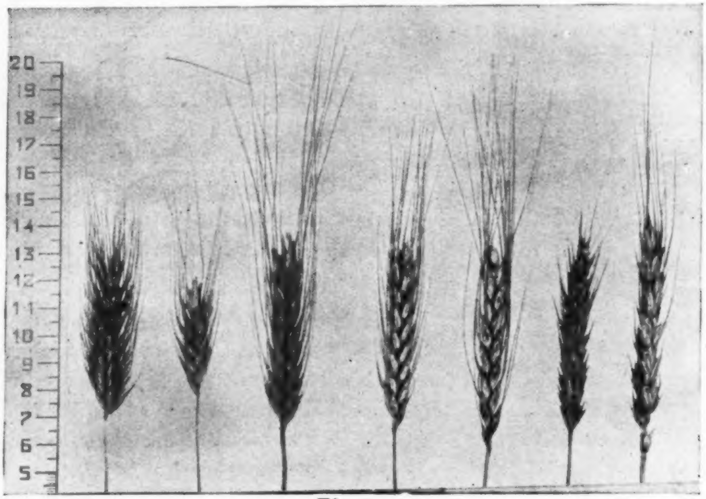

Fig. 1.

Spikes. From left to the right: (1) *Haynaldia villosa*, (2) Hybrid *Triticum Timopheevi* × *Haynaldia villosa*, (3) *Tr. Timopheevi*, (4) Hybrid *Triticum dicoccum* × *Haynaldia villosa*, (5) *Tr. dicoccum*, (6) Hybrid *Triticum vulgare* × *Haynaldia villosa*, (7) *Triticum vulgare*.

The plants grown in 1935 resulted from free blooming of the F_1 — hybrid *Tr. dicoccum* × *Haynaldia villosa*. One of them had 42 somatic chromosomes, while the other one had 28 somatic chromosomes. Both plants were self-sterile. The former plant has probably resulted from a cross pollination of the hybrid (*Tr. dicoccum* × *Haynaldia villosa*) with *Tr. vulgare*. The female gamete obviously has not been reduced, containing complete chromosome sets from *Tr. dicoccum* ($n = 14$) and *Haynaldia villosa* ($n = 7$); the hybrid being a hexaploid one and having all chromosomes from three different species, namely, *Tr. dicoccum*, *Tr. vulgare* ($n = 21$) and *H. villosa*. It was self-sterile.

In 1936 we grew one plant from the cross (*Tr. dicoccum* × *H. villosa*) × *Secale cereale* ($n = 7$). The hybrid has 28 somatic chromosomes and represents a trigeneric hybrid which has all the chromosomes from *Tr. dicoccum*, *H. villosa* and *S. cereale*, *i.e.*, 14 ÷

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[1] Tschermak, E., "Ein neuer fruchtbarer Weizenbastard (*T. turgidum* × *T. villosum*)", *Forsch. auf d. Geb. d. Pflanzenbaus u. d. Pflanzenzüchtung Festschr. Rümker*, P. Parey, Berlin, 1929.

[2] Berg, H. K., "Cytologische Untersuchungen an *Triticum turgidovillosum* und seinen Eltern", *Zeitschr. für ind. Abst. u. Vererbgsl.*, 1934, **67**, 342-373.

$7 \div 7 = 28$[3] (see Kostoff and Arutiunova, 1936). Another cross combination represented: (*Tr. dicoccum* × *H. villosa*) × *Tr. Timopheevi* ($n = 14$). We grew seven hybrids from this cross combination. Six of them were real triple hybrids, while one was an amphidiploid *Tr. dicoccum* × *H. villosa*, originating probably apomicticly. Five of the triple hybrids had 35 somatic chromosomes, *i.e.*, 14 from *Tr. dicoccum* ÷ 7 from *H. villosa* ÷ 14 from *Tr. Timopheevi*. They have obviously originated from unreduced egg cells fertilized with normal gametes from *Tr. Timopheevi*. One plant of the triple hybrids had 32 somatic chromosomes. It has probably originated from an egg cell having not a complete somatic chromosome number but only 18 chromosomes and a normal sperm cell from *Tr. Timopheevi*. The triple hybrids had almost an intermediate appearance between the component parental species and are highly sterile. In the I metaphase of the reduction division most frequently 9 univalents and 13 bivalents were found, but tri- and tetravalents were also seen. Two more amphidiploid plants were produced from the hybrid (*Tr. dicoccum* × *H. villosa*) when the F_1-hybrids bloom free in the field together with other plants, without isolation.

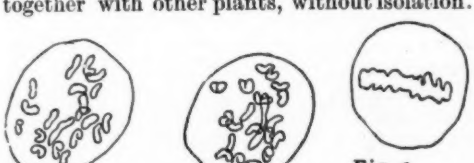

Fig. 2.

Meiosis in *Triticum dicoccum* × *Haynaldia villosa*, hybrid. First two pollen mother cells having each one a single bivalent chromosome with terminal chiasma. Third cell—second metaphase—all chromosomes being in one plate (failure of the first meiotic division). This condition leads to formation of gametes with somatic chromosomes number.

Amphidiploid *Tr. dicoccum* × *Haynaldia villosa* has completely normal pollen (98% viable). During the reduction division we have found usually 21 bivalents or 20 bivalents and 2 univalents. In exceptional cases more than two univalents were seen. Reduction division proceeds usually quite normal but irregularities were also found. The univalent chromosomes seem to be the chief cause for these irregularities. They were found outside of the I metaphase plate or on the equatorial plain during the I anaphase. Occasionally II metaphases with 21 ± 1 chromosomes were seen. In certain cases the univalents remain on the spindle even during the I telophase. They are probably responsible for some of the irregularities during the second division.

In a few cases one univalent divided during the first division. This also leads, no doubt, to certain irregularities in the second division. It is very probable that the chromosomes (perhaps the majority) lagging on the spindles during the second division represent halves of univalent (or univalents) which have divided during the first division. Most frequently, however, the univalents split only during the first division and probably divide during the second one.

The tetrads formed after the second division are usually equal. The laggards on the spindle during the second division form in certain cases micronuclei, but such cases were rarely observed. We studied several hundreds of PMC in tetrad stage (aceto-carmine preparations) and saw only a few such cells. Counting 63 PMC in tetrad stage —62 had normal tetrads and only in one PMC one pentad was seen (four large microspores and one very small).

Ampbidiploid *Tr. dicoccum* × *Haynaldia villosa* seems to have relatively normal reduction division in the embryo-sac too, because the plant is fully fertile.

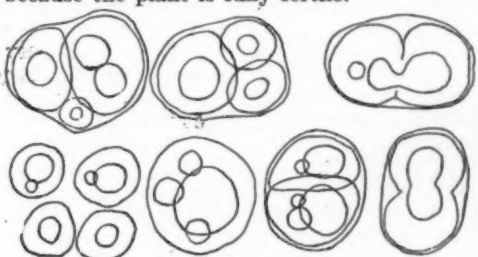

Fig. 3.

Tetrad stage in the hybrid *Triticum dicoccum* × *Haynaldia villosa*.

Crossing F_1 (*Triticum vulgare* × *Haynaldia villosa*) with *Tr. vulgare* two plants were obtained, both having ca. 48–49 somatic chromosomes. They have probably originated from fusions of unreduced egg cells with normal *Tr. vulgare* sperm cells, *i.e.*, 21 *vulgare* ÷ 7 *villosa* ÷ 21 *vulgare* = 49 somatic chromosomes. The reduction division of one of these plants was studied in aceto-carmine preparations and about 7 univalents and 21 bivalents were observed.

Finally one plant with 40 somatic chromosomes was obtained in crossing F_1 — (*Tr. dicoccum* × *H. villosa*) with *Tr. Timopheevi*. This plant has probably originated when a normal sperm cell of *Tr. Timopheevi* has fertilized an egg cell with 26 somatic chromosomes.

[3] Kostoff, D., and Arutiunova, N., "Studies on polyploid plants XIV. The behaviour of *Haynaldia* genom in the trigeneric triple hybrid. (*Triticum dicoccum* × *Haynaldia villosa*) × *Secale cereale*". (In press), 1936.

A Photoconductive Photometer—A New Method and Apparatus for the Quantitative Estimation of Chlorophyll.

By B. N. Singh and N. K. Anantha Rao.
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ATTENTION has not infrequently been drawn to the need for a simple method of estimating chlorophyll, since chlorophyll is so closely related to plant metabolism, its chemical composition and area, and is influenced by such factors as light, temperature and manurial treatment. The study of the various aspects of the rôle of chlorophyll in plant life, demands a method of its determination which shall be applicable to small quantities of material, open to minimum error, reasonably simple and quick enough to enable a large number of quantitative estimations to be made at a time and be of general application for work on chlorophyll.

The generally employed spectrometric methods are neither speedy nor practicable for a considerable number of determinations. Moreover, the conversion from the original extract produces errors much too large for experimental purposes. Although the colorimetric methods possess many advantages, certain imperfections do exist, the elimination of which appears to be desirable. Every separate test by comparison demands the existence of a standard solution. Standard solutions are, however, a source of recurring trouble not only because of the inconvenience involved in their preparation, but also for many other reasons, including their lack of permanence, disparities of colour and so forth. This precaution should be strictly observed in chlorophyll estimations since chlorophyll is known to decompose even in the dark. The colorimetric method is more accurate at lower concentrations while the spectrometric is more accurate at higher concentrations.[1] Recently Oltman,[2] has developed a simple method using a photo-electric cell. The method, while useful in many respects, suffers from certain disadvantages. The difference in accuracy between high and low concentrations is great. The loss of light in the solvent and on the cell windows is not compensated. Being a direct method it has the obvious disadvantage of lack of sensitivity.

To circumvent the defects inherent in the earlier methods, the following method and apparatus has been developed in this laboratory and has been in use for some time.

The principle essentially consists in determining the amount of light absorption of an alcoholic extract of plant pigments within a narrowly defined region of the spectrum, for which the chlorophylls possess a marked absorption, while the absorption of the other pigments is infinitesimal.

Concentration of substances in solution are determined by absorption measurements depending upon Lambert-Beer law, "The extinction coefficients (E) at equal stratum thickness bear the same proportion to each other as the concentrations (C) of the dissolved substances" consequently $E_1 : E_2 = C_1 : C_2$ or $C_2 = C_1 \frac{E_2}{E_1}$. The concentrations are easily determined when once a series of measurements are recorded *in the same region of the spectrum*, on a suitably graduated range of solutions having known concentrations. In an alcoholic extract (80% methyl alcohol) of green plant tissue containing flavones, chlorophyll ($a + \beta$), carotin and xanthophyll, the pigments exhibit certain definite absorption characteristics. The chlorophylls are unique in possessing a marked absorption in the red region for which the absorption of the others is infinitesimal. The carotenoids possess a marked absorption in the blue for which the absorption of the chlorophylls is little. The concentration of the chlorophyll or the carotenoids (total) can be determined in the above extract quite independently of each other provided that only those spectral filters are employed whose transmission ranges correspond to the infinitesimal absorption of the components in solution. Independent investigations (to be described elsewhere) have shown that the transmission in red from the above extract is a true measure of chlorophyll concentration and that it is unaltered by the yellow pigments (Fig. 1).

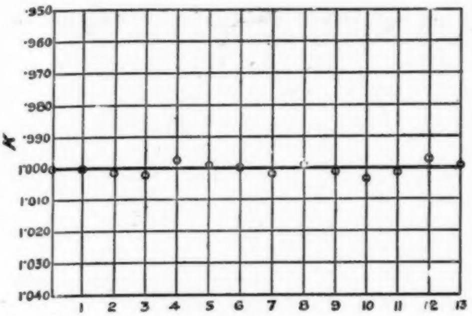

Fig. 1.

Drops of Carotenoids added.

Stratum Thickness 30 mm.

Extinction coefficient values (K) obtained from a solution of chlorophyll (in 80% methyl alcohol), to which an alcoholic extract of carotenoids has been added in increasing proportion.

The apparatus is represented diagrammatically in Fig. 2. The source of light L supplies two equal beams of light. Two absorption cells V_1 and V_2 of equal stratum thickness* are interposed in the path of the light, one on each side. During experimentation one of them is filled with the alcoholic extract and the other with the pure solvent. By this arrangement the loss of light in the solvent and on the cell windows is compensated. The transmitted lights from the absorption cells pass through the red spectral filters F_1 and F_2 (transmission 6200–6800 Å) and fall on the two selenium cells S_1 and S_2 mounted *in vacuo*, where the effect of radiation appears as an increase in conductivity of the cells. The change of conductivity is proportional to the transmitted light. Compensating device which converts direct reading into null-method is employed; the balance being effected by adjusting the lights that alter the currents by changing the conductivity of the selenium cells. The circuit is essentially of the bridge type, G being a sensitive galvanometer. The differences if any in the two cells are eliminated by the use of the common battery and shunted by R.

The selenium cell is specially selected on account of its maximum sensitivity, constancy and quickness of response to radiation and *its linear response with illumination in the spectral region employed.*

* To be determined according to the experiment.

For making an estimation the absorption cells are first removed and the light adjusted to equal intensity, as indicated by the null-point.† Now the pigment extract is put in one absorption cell and the solvent in the other. More light is transmitted by the latter, which throws the bridge out of balance and is indicated by the deflection of the galvanometer. In front of the absorption cells are the light apertures Lo_1 and Lo_2 (→←) whose opening can be measurably varied by the arrangement shown in Fig. 2*b*. The amount of opening is indicated by the degree of turning of W. This directly gives the value of the transmitted light as a percentage of the incident. By gradually diminishing the light on the side of the solvent, the transmitted lights are adjusted to equal intensity as indicated by the null-point. The measurement should be repeated interchanging the absorption cells V_1 and V_2 and the average value taken. This compensates any variations in wall thickness of the absorption cells. From the value obtained the extinction coefficient is extracted and the concentration determined.

The following are some of the data obtained by the above method in an investigation on the effect of temperature on chlorophyll formation in etiolated seedlings of *Pisum sativum*.

TABLE I.

Mgms. of chlorophyll per unit weight of material.

Temperature	Time				
	1st hour	2nd hour	3rd hour	4th hour	5th hour
10° C.	0	0	0	0	4
15° C.	0	0	0	7	9
20° C.	0	0	8	10	13
25° C.	0	9	11	13	21
30° C.	0	10	13	15	19
35° C.	0	0	10	12	14
40° C.	0	0	0	2	4

The suitable range of temperature for the formation of chlorophyll seems to be 20° C.—35° C. in the example studied.

† For obtaining this R may be used as a fine adjustment.

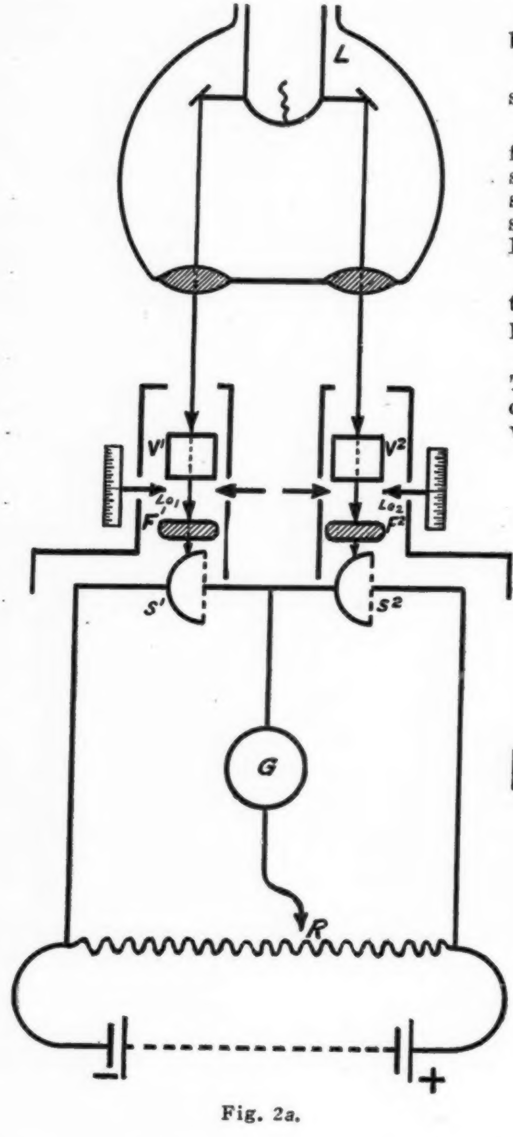

Fig. 2a.

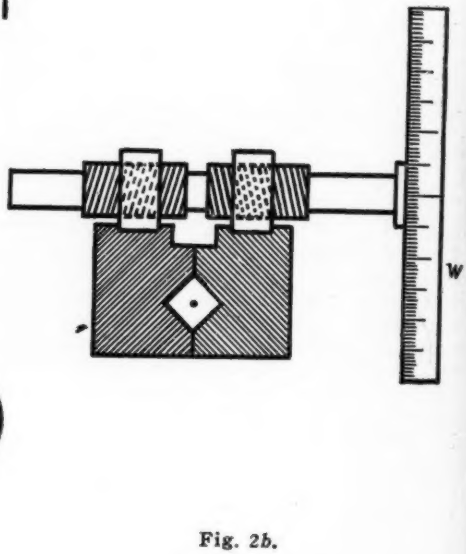

Fig. 2b.

The special advantages of the procedure over the earlier ones are :

1. The estimations are quick as the laborious process of separation of pigments is eliminated.

2. The transmission values are arrived at by exact physical measurements.

3. The null method is more accurate and sensitive than direct reading methods.

4. Accuracy can be maintained for different concentrations by change of the stratum thickness of the absorption cells, since the transmission is dependent upon stratum thickness according to Lambert-Beer law.‡

5. The loss of light in the solvent and on the windows of the absorption cells is compensated.

The accuracy of the method is $\pm 2 \cdot 0\%$. The various details as to construction, calibration and methods of experimentation will appear elsewhere.

‡ The transmission values should be converted to unit thickness.

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2. Oltman, R. E., *Plant Physiology*, 1933, **8**.

LETTERS TO THE EDITOR.

The Median as a Statistic.

AN impetus to the use of the median in statistical analysis has undoubtedly been given in recent years by P. R. Crowe.[1, 2, 3] In justifying some of the rules he has given, Crowe has either appealed to intuition or assumed normality of distribution. As can be seen from below *we can deduce some rules which are entirely independent of the frequency distribution in the population from which our sample was obtained.*

Suppose we have a sample of n values and we wish to know the median of the population from which that sample was obtained. We proceed as follows.

By definition, the median of a population is such that the chance of obtaining at random from that population a value which is either greater or less than the median is $\frac{1}{2}$.

Hence the chance of obtaining in a random sample of n values from that population not more than l values which are less than the median is given by

$$P = \frac{1}{2^n}\left(1 + {}_nC_1 + \ldots + {}_nC_l\right)$$
$$= I_{\frac{1}{2}}\,(n - l,\, l + 1) \qquad \ldots \qquad (1),$$

where $I_{\frac{1}{2}}\,(n - l,\, 1 + 1)$ is an incomplete β-function ratio written after the manner of K. Pearson.[4]

For a given value of P and n, equation (1) can be solved for l.* Let us choose some limit for random chance, say 5%. We put $P = 0{\cdot}05$ in (1) and solve for l. In general we will get two values of l differing by unity such that the values of P corresponding to these two values of l will be on either side of $0{\cdot}05$. We choose l_1, the smaller of the two values.

Let us arrange the n values of our sample in the ascending order of magnitude thus:

$$y_1, y_2, \ldots y_{l_1}, \ldots y_{n+1-l_1}, \ldots y_n.$$

It is clear that if म,† the median of the population from which our sample was obtained, is equal to or less than y_{l_1}, the chance is less than $0{\cdot}05$ of obtaining from that population a random sample of n values in which there are not more than l_1 values below म, that is to say, on our limit of 5% for random chance our sample could not have been obtained from a population

* The method of solution will be given in a fuller paper which will be published elsewhere.

† The word मध्यम means middle or central in Sanskrit. We will thus use the first letter म to denote the value of the median in the population. म is pronounced like *me* in calmer.

in which म is equal to or less than y_{l_1}. Thus म $> y_{l_1}$.

In a similar manner we can show that on the same limit for random chance म is less than y_{n+1-l_1}.

Thus $y_{l_1} <$ म $< y_{n+1-l_1}$ .. (i)

Now the y's are measured correct to a certain number of significant digits. We increase y_{l_1} and decrease y_{n+1-l_1} by unity in the last significant digit. Let the values thus obtained be denoted by y'_{l_1} and y'_{n+1-l_1} respectively. We can now rewrite (i) as

$y'_{l_1} \leqslant$ म $\leqslant y'_{n+1-l_1}$ .. (ii)

Since the limits y'_{l_1} and y'_{n+1-l_1} were obtained on the 5% limit for random chance, we well term them the 5% limits, and the interval from y'_{l_1} to y'_{n+1-l_1} the 5% interval.

In deducing (i) and (ii) we have assumed that

$$y_{l_1} < y_{l_1+1} \text{ and } y_{n-l_1} < y_{n+1-l_1}$$

If, however, $y_{l_1} = y_{l_1+1}$ and $y_{n-l_1} = y_{n+1-l_1}$, it can be easily seen that (i) and (ii) will have to be replaced by

$y_{l_1} <$ म $< y_{n+1-l_1}$ .. (iii)

In a similar manner we can obtain the interval on any other limit for random chance.

Suppose for the sake of definiteness we use 5% as our limit for random chance. Then our tests of significance may be stated thus:

(1) The median of a random sample is significantly different from zero if the 5% interval for it does not contain zero.

(2) The medians of two random samples are significantly different from each other if the 5% intervals for them do not have a common part.

We shall apply these tests to the example given on page 113 of R. A. Fisher's book.[5]

(*a*) Suppose the drugs were given to the same patient. Then we must use the last column in the table on page 113 of (5). Arranging the values in the ascending order of magnitude we get

$0{\cdot}0$, $+0{\cdot}8$, $+1{\cdot}0$, $+1{\cdot}2$, $+1{\cdot}3$, $+1{\cdot}3$, $+1{\cdot}4$, $+1{\cdot}8$, $+2{\cdot}4$, $+4{\cdot}6$. The median is $+1{\cdot}3$.

Since $n = 10$, we find on the 5% limit for random chance that $l_1 = 1$. Hence y_{l_1} and y_{n+1-l_1} are $0{\cdot}0$ and $+4{\cdot}6$; and so y'_{l_1} and y'_{n+1-l_1} are $+0{\cdot}1$ and $+4{\cdot}5$. Thus the 5% interval is from $+0{\cdot}1$ to $+4{\cdot}5$.

Since this interval does not contain zero we see that the *median* of the series is significant. Fisher, using "Student's" t test in which normality of distribution is assumed, finds that on the 5% limit for random chance the *mean* of the series is significant.

(*b*) Suppose the drugs were given to twenty different people. We must, in this case, use the columns under 1 (Dextro –) and 1 (Lævo –) separately. Arranging the values in the ascending order of magnitude, the two series are

(a') $-1{\cdot}6$, $-1{\cdot}2$, $-0{\cdot}2$, $-0{\cdot}1$, $0{\cdot}0$, $+0{\cdot}7$, $+0{\cdot}8$, $+2{\cdot}0$, $+3{\cdot}4$, $+3{\cdot}7$.

(b') $-0{\cdot}1$, $+0{\cdot}1$, $+0{\cdot}8$, $+1{\cdot}1$, $+1{\cdot}6$, $+1{\cdot}9$, $+3{\cdot}4$, $+4{\cdot}4$, $+4{\cdot}6$, $+5{\cdot}6$.

The 5% interval for (a') is $-1{\cdot}5$ to $+3{\cdot}6$, and that for (b') is $0{\cdot}0$ to $+5{\cdot}5$. Since these two intervals have a common part we conclude that the two medians are not significantly different from each other on the 5% limit for random chance. Using the t test, Fisher finds that the means of the two samples are not significantly different from each other on the same limit for random chance.

Advantages of the median over the mean in tests of significance.—

(1) The tests given above are far simpler than those in which the mean is used.

(2) For any test in which the mean is used it is essential to know (or to assume) the distribution in the population, whereas such a knowledge is not required in the case of the median.

The paper, in which the use of the median as a statistic is discussed in more detail, is under preparation and, as mentioned above, will be published elsewhere.

S. R. SAVUR.

Poona 5,
January 15, 1937.

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[2] H. A. Mathews, *Scott. Geog. Mag.*, 1936, **52**, 84-97.

[3] P. R. Crowe, *Geographical Review*, 1936, **26**, 463-484.

[4] K. Pearson, *Tables of the Incomplete β-Function*, The "Biometrika" Office, University College, London.

[5] R. A. Fisher, *Statistical Methods for Research Workers*, 1932, 4th edition.

Raman Spectrum and Constitution of the $(NO_3)^-$ Ion.

THE Raman spectra of inorganic nitrates in the crystalline state as well as in aqueous solutions have been studied by a number of workers.[1] Krishnamurti[2] examined by the powder technique the spectra of a large number of crystalline nitrates, some in the anhydrous condition and others as hydrates. In all cases, he found an intense Raman line near about 1050 cm.$^{-1}$ while two other fainter lines near about 720 and 1360 cm.$^{-1}$ were also present in the spectra of certain nitrates. Nisi[3] obtained similar results in the case of $NaNO_3$, KNO_3 and NH_4NO_3, working with single crystals of these substances. Raman spectra of aqueous solutions of nitrates studied by Grassmann,[4] Nisi[5] and others show that there is a splitting of one or both of the frequencies 720 and 1360 into two more or less diffuse components.

Placzek[6] has remarked that evidence from Raman and infra-red spectra suggests a plane structure for the $(NO_3)^-$ ion, with the symmetry D_{3h}. It will then have four distinct fundamental frequencies of which two are doubly degenerate. The selection rules show that the degenerate frequencies are allowed in the Raman effect as well as in the infra-red; the totally symmetric vibration is forbidden in the infra-red but can be expected to appear with great intensity in Raman effect; the perpendicular vibration is forbidden in the Raman effect but is allowed in the infra-red. Infra-red absorption spectrum of $NaNO_3$ studied by Schæfer and his co-workers[7] shows absorption maxima in the neighbourhood of 720, 830 and 1360 cm.$^{-1}$ The frequency 830 is not observed in the Raman effect, while the most intense Raman frequency near 1050 fails to appear in the infra-red. These facts suggest that 720 and 1360 represent the degenerate, 1050 the totally symmetric and 830 the perpendicular, frequencies of the $(NO_3)^-$ ion. The observed splitting of the degenerate frequencies in aqueous solutions of nitrates is then left unexplained.

Recently, I have taken up a systematic investigation of the Raman spectra of inorganic nitrates, and have obtained results which appear to be of significance in this connection. Employing the technique of complementary filters[8] I have photographed the Raman spectra of a large number of crystalline nitrates of mono-, bi- and trivalent metals. Most of the salts studied by me were hydrated, and contained the appropriate number of molecules of water of crystallisation. Typical photographs of the spectra obtained in a few cases are reproduced in Fig. 1.

In almost all cases, the spectra reveal many new and interesting features which have been entirely overlooked by the previous investigators. Not the least important of these is the water-band in the 3μ region in the case of the hydrated salts, which shows amazing changes in intensity and structure from substance to substance. As regards the vibrational frequencies of the $(NO_3)^-$ ion, the most salient features are the following :—

(i) In the case of crystalline $NaNO_3$—this does not contain water of crystallisation—three vibrational frequencies are observed which correspond to those reported by previous investigators. *All these three are very sharp lines*, the one near 1060 being the most intense.

(ii) The spectra of the nitrates of bi- and tri-valent metals—all the substances examined so far are hydrated crystals—show that in all cases the frequencies near 720 and 1360 are split up into two or more components which are generally broad and diffuse in the case of the higher frequency. The most intense nitrate frequency near 1050 cm.$^{-1}$ also shows large structural changes from one nitrate to another. It is sharp in the case of $Mg(NO_3)_2 \cdot 6H_2O$, shows

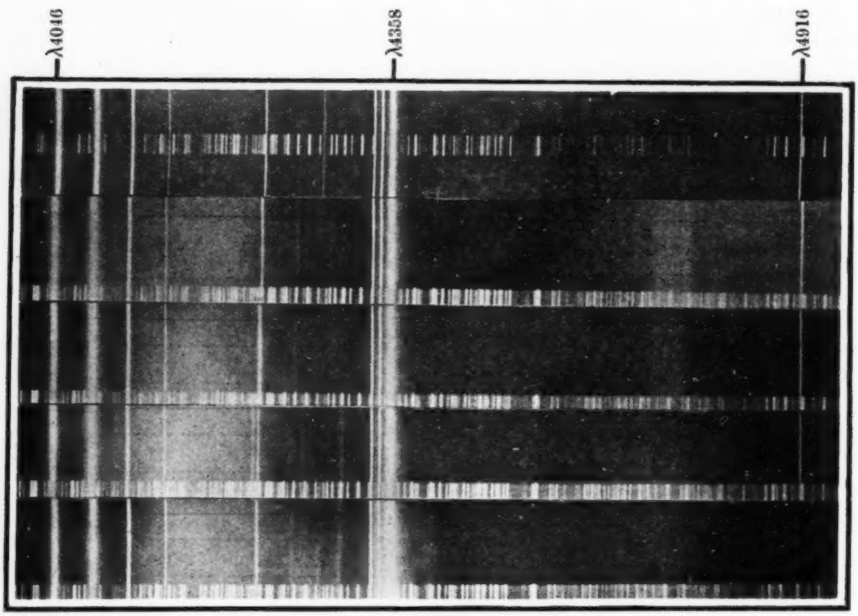

Fig. 1.

Raman spectra of crystalline nitrate.

a wing to its left in the spectrum of $Bi(NO_3)_2 \cdot 5H_2O$, is just split up into two components of equal intensity in the spectrum of $Ce(NO_3)_3 \cdot 6H_2O$, and appears as two well-separated components of unequal intensity in the Raman spectrum of $Cu(NO_3)_2 \cdot 3H_2O$. A surprising feature of the Raman spectrum of $Cu(NO_3)_2 \cdot 3H_2O$ is the appearance of as many as eight distinct frequencies in the spectral region between 700 and 1500 wave numbers.

The significance of these and other results obtained in this connection will be discussed in a paper which will appear shortly in the *Proceedings of the Indian Academy of Sciences.*

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Department of Physics,
Indian Institute of Science,
Bangalore,
February 12, 1937.

[1] For the complete bibliography, see "Raman Effect" (J. Weiler), *Landolt Börnstein Physikalisch-Chemische Tabellen*, 1935, 938-40.

[2] P. Krishnamurti, *Ind. Jour. Phys.*, 1930, **5**, 1.

[3] H. Nisi, *Proc. Phys. Mat. Soc. Japan*, 1933, **15**, 114.

[4] P. Grassmann, *Z. f. Phys.*, 1932, **77**, 616.

[5] H. Nisi, *Loc. cit.*

[6] G. Placzek, *Handbuch der Radiologie*, 1934, **Teil II**, 309.

[7] C. Schæfer and C. Bormuth, *Z. f. Phys.*, 1930, **62**, 508.

[8] R. Ananthakrishnan, *Curr. Sci.*, 1936, **5**, 131; *Proc. Ind. Acad. Sci.*, (A), 1937, **5**, 76.

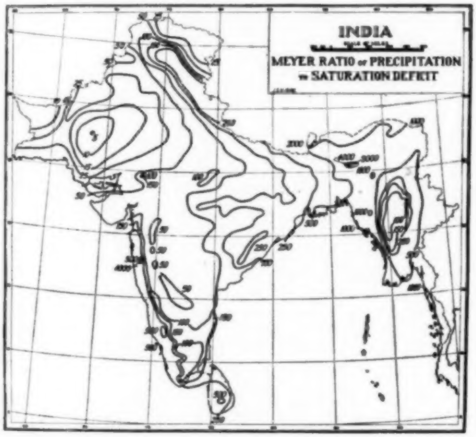
The Ratio of Precipitation to Saturation Deficiency of the Atmosphere in India.*

DURING the course of an investigation into the possible relationships between the black earths of Australia and the regur of India[1] (Hosking, 1935) certain climatic values were calculated for India in order that a comparison might be made of the general climatic factors controlling the occurrence of these soils.

Of the various single value climatic factors employed in the study of the connection between climate and soil distribution, Meyer[2] (1926) considered the simple ratio of precipitation (rainfall in inches) to the absolute saturation deficiency of the atmosphere (in inches of mercury) to be the

* From the Division of Soils, Council for Scientific and Industrial Research, Australia.

most efficient for this purpose and mapped the distribution of this ratio for Europe. In an attempt to correlate the soils of the United States of America with those of Europe, Jenny[3] (1929) covered that country in a similar manner. Following a critical examination of the various factors considered, Prescott[4] (1934) has substantiated the recommendation of Meyer and considers the Meyer ratio the most expressive in a preliminary study of the relationships between climatic conditions and the geographical distribution of plants, animals and soils and calculated the values for Australia. So far the distribution of this factor for India has not been attempted. Raman and Satakopan[5] (1935) have, however, characterised the climate of India by means of the single value factor "the annual rainfall *minus* the annual evaporation". They estimated the monthly and annual evaporation for 80 stations throughout India, saturation deficiency being the most important factor concerned in these estimations. The map presented in this paper extends Meyer's method to the study of Indian data.



The information for the purposes of calculating this data was drawn from the monthly reports of the Indian Weather Review up to the end of 1934 supplemented by various memoirs of the Indian Meteorological Department.

The mean annual temperature and water vapour pressures, calculated in the usual manner from the mean monthly values recorded, were the observations employed in calculating the saturation deficit. Maps showing their distribution were first constructed, interpolations for height above sea-level being necessary in certain areas, in which a good agreement was obtained in cases where data for "Hill stations" could be compared. From these a satisfactory distribution for saturation deficit was obtained. In the final preparation of the Meyer ratio map the calculated values for the given localities were entered and interpolations made by superimposing the rainfall map on that showing the saturation deficiency.

The extreme conditions of aridity in the region of the Thar Desert and Indus Valley and of humidity along the western coastal regions of India, Burma and Assam and throughout Bengal and Assam are emphasised. A minimum value of approximately 5 for the Meyer ratio is shown in the vicinity of Sukkur in the Sind Province, while Cherrapunji in the Khasi Hills of Assam records a maximum value of over 4,000.

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Adelaide, S. Australia.

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3 Jenny, H., *Soil Research*, 1929, **1**, 139.
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Crystal Structure of *p*-Azotoluene—Space Group.

The crystals of *p*-azotoluene belong to the monoclinic prismatic class and the axial ratio is

$$a : b : c = 2{\cdot}1768 : 1 : 1{\cdot}9674, \beta = 90°16'.^{1}$$

Rotation photographs taken about the *a*, *b* and *c* axes gave the following axial lengths:

$$a = 12{\cdot}0 \text{ Å},\ b = 4{\cdot}85 \text{ Å},\ c = 9{\cdot}703 \text{ Å}.$$

The axial ratio $(a : b : c :: 2{\cdot}474 : 1 : 2{\cdot}00)$ calculated from the above dimensions for the unit cell gives for the interfacial angles values which are in very good agreement with those measured by Groth. The oscillation photographs taken about the three axes show that (hol) planes are halved when *h* is odd and (010) is also halved. The crystals therefore belong to the space

group C_{2h}^5. The calculated number of molecules in the unit cell is two. This indicates that the molecules possess a centre of symmetry.

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Chemical Laboratory,
The Royal Institute of Science,
Bombay,
January 16, 1937.

[1] *Cf.* Groth, *Chem. Krystallg.*, **5**, 66.

Isosterism and Constitution of Diazomethane and its Derivatives.

THE cyclic structures originally given by Curtius for diazomethane and its derivatives, were subsequently abandoned when Angeli, Thiele and Staudinger showed that these give rise to open chain compounds and hence should possess the open structures. Based upon the linear structure, Bradley and Robinson have explained all the reactions of the diazenes according to the electronic theory.[1]

During the past few years a good deal of physical measurements have been made with a view to decide between the alternative structures. The parachor has been shown to be incapable of decisive value. The dipole moment favours the ring structure though it can also be compatible with open chain resonance structures. Evidence from absorption spectra is variously interpreted. The method of electron interference seems to support the ring form. There is obviously great difficulty in employing the physical measurements satisfactorily owing to peculiarities connected with this group of compounds. Useful information can be obtained from analogy with the azides, which are more easy to work with. Cumulative evidence from thermo-chemical measurements, Raman spectra and X-ray crystal analysis indicate that the azides have a linear structure and the low value of dipole moments could be attributed to the existence of resonance.

Further support for the open structure is available from considerations of Isosterism. Langmuir[2] stated that azides are isosteric with isocyanates and diazomethane isosteric with ketene. The isosterism between azides and isocyanates has been examined by Pauly and Hendricks[3] who showed that they have very similar physical properties. No data have been collected till now, in regard to isosterism between ketene and diazomethane. Very few physical properties have been studied owing to the difficulties attendant on the examination of these highly reactive compounds. The available data are given below:

	Diazomethane.	Ketene.
Boiling Point	$-24°$ to $-23°$C.	$-56°$C. ($-41°$C.)
Freezing Point	$-145°$C. $-151°$C	($-134{\cdot}6°$C.)

The values for the ketene given in the brackets are more recent and given by Rice, Greenberg and others.[4] Langmuir's suggestion that the two are isosteric seems to be supported by the above properties. The resemblance in chemical properties is well known. Compounds that are isosteric have similar structures. There is only one possible structure for the ketene, which is the open form; $\begin{matrix}H\\H\end{matrix}\!\!>C=C=O$; and hence diazomethane should be expected to have the open structure: $\begin{matrix}H\\H\end{matrix}\!\!>C=N\rightarrow N$.

I wish to thank Dr. T. R. Seshadri for advice.

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Department of Chemistry,
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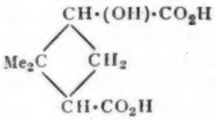
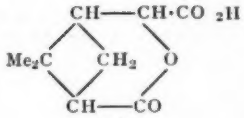
and Technology,
Waltair,
February 3, 1937.

[1] Bradley and Robinson, *J.C.S.*, **1928**, 1310.
[2] Langmuir, *J.A.C.S.*, **1919**, 1544.
[3] Pauly and Hendricks, *J.A.C.S.*, 1926, 641.
[4] Greenberg and others, *J.A.C.S.*, **1934**, 1764.

The Configuration of Pinic Acid.

SINCE pinic acid, obtained from *cis*-pinonic acid by alkaline hypobromite, is degraded to *cis*-norpinic acid, Perkin and Simonsen[1] concluded that pinic and hydroxy-pinic acids possess *cis*-configuration. The fact that hydroxy-pinic acid (I) in spite of its being a δ-hydroxy acid does not form a lactone (II)[1,2] led us to suspect that this acid as also pinic acid from which it is derived might possess *trans*-configuration. The elucidation of the configuration of pinic acid was taken up first by (i) independent synthesis which is in progress and (ii) by a comparison of the properties of pinic acid (III) obtained by oxidising the glycol (IV) which has been proved by us[3] to be of the *trans*-configuration.


(I)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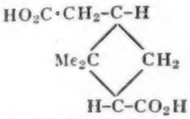
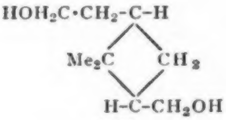

(III), (IIIa)


(IV)

Recently, the abstract of a paper by Grandperrin[4] came to our notice wherein he has suggested, though with some negative experimental evidences only, the pinic acid (IIIa) obtained by the alkaline oxidation of *cis*-pinonic acid to be of the *trans*-form. In view of this publication we hasten to present the experimental evidences so far obtained by us, which definitely confirm that pinic acid is of the *trans*-form.

Pinic acid (IIIa) (b.p. 206–207°/6 mm.) has now been prepared directly from *cis*-pinonic acid and its diethyl ester reduced by sodium and alcohol to the glycol (IV) which on oxidation with permanganate gave pinic acid (III) (b.p. 204–05°/5 mm). This acid, by analogy with our previous work[3] should possess the *trans*-configuration. The identity of the two acids (IIIa) and (III) (*cf.* B.P. identical) has been further established by the fact that both of them give the same dianilide (m.p.'s and mixed m.p. 204°) and diamide (m.p.'s and mixed m.p. 222–23°).

P. C. Guha.
K. Ganapathi.
V. K. Subramanian.

Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
January 22, 1937.

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[1] *J.C.S.*, 1909, **95**, 1176.

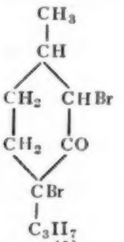
[2] Bayer, *Ber.*, 1896, **29**, 1908.

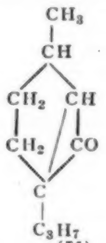
[3] Guha and Ganapathi, *Curr. Sci.*, 1936, **5**, 244.

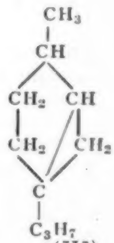
[4] *Am. Chem. Abst.*, Nov. 20, 1936, **30**, 8191; *Annalen der Chemie*, 1936, **6**, 5–53.

Synthesis of Thujane.

Thujane, the parent hydrocarbon of the naturally occurring bicyclic terpenes of this group, appears to have been synthesised starting from menthol as follows: menthol is oxidised to menthone (b.p. 98–100°/18 mm.; semicarbazone m.p. 185°, the lowest m.p. recorded in literature being 185°), which gives a dibromo-derivative, *viz.*, 2 : 6-dibromo-3-methyl-6-isopropyl-cyclohexane-1-one[1] (I). This dibromo-derivative on treatment with zinc dust in alcoholic solution has yielded the bicyclo-(0 : 1 : 3)-hexane derivative (II), b.p. 205–07° at ordinary pressure and 110–112°/14 mm.; $n_D^{23°}$ 1·4505. It gives two isomeric semicarbazones, one melting at 175–76° and the other melting at 150–51°. The bicyclic ketone (II) on reduction by Clemmensen's method, *viz.*, by zinc amalgam and hydrochloric acid has yielded thujane (III), b.p. 156–57°; $d_4^{22°}$ 0·8140; $n_D^{20°}$ 1·4410; the corresponding values of Thujane as given by Semmler and Feldstein[2] being b.p. 156–57°; $d_{21°}^{22°}$ 0·8158; n_D 1·44121. The identity of the synthetic variety of thujane has also been established by comparing its properties with those of thujane prepared by direct reduction of thujone by Clemmensen's method.


(I)


(II)


(III)

The synthesis of thujane by Ruzicka and Koolhaas[3] from α-thuja-ketonic acid (a direct degradation product of thujone) being only a partial synthesis, the present synthesis constitutes the first total synthesis of a bicyclic compound of this group of terpenes, subject to further confirmation.

Our thanks are due to Mr. S. Krishna Moorthy for rendering some help in the preparation of the starting materials.

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Bhola Nath.

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[1] Beckmann, Eickelberg, *B.*, **29**, 418.

[2] *Ber.*, 1914, **47**, 387.

[3] *Helv. Chim. Acta.*, 1932, **15**, 944.

Constitution of Butrin Isolated from *Butea Frondosa* Flowers.

THE crystalline glucoside butrin, $C_{27}H_{32}O_{15}2H_2O$ isolated from the flowers of *Butea Frondosa*, has been shown to be a glucoside of butin, which is 3 : 4 : 7 trihydroxy flavanone. It is obtained from hot alcohol as dihydrate (most stable) tiny silky needles, $[\alpha]_D^{31^\circ \cdot 5} = -73^\circ \cdot 27$ in water (C, 0·396) and as pentahydrate (silky needles) from hot water; the pentahydrate loses $3H_2O$ on keeping over H_2SO_4 or $CaCl_2$ for ten days at ordinary temperature. Anhydrous (I) $[\alpha]_D^{30^\circ} = -81 \cdot 7$ in pyridine (C, 1·681) obtained by heating dihydrate or pentahydrate at 120° is hygroscopic and readily takes up $2H_2O$ from air.

On hydrolysis with dilute mineral acids (I) gives 2 molecules of glucose and one molecule of butin, $C_{15}H_{12}O_5$ which is 3′ : 4′ : 7 trihydroxy flavanone. It contains nine hydroxy groups but yields by the action of acetic anhydride and anhydrous sodium acetate at 130–135°, a deca-acetyl derivative $C_{27}H_{22}O_5(O.CoMe)_{10}, H_2O$, on account of the rupture of the pyrone ring with simultaneous acetylation of the newly formed phenolic hydroxy group of the chalkone, as pale flakes from methyl alcohol, m.p. 119–120°, $[\alpha]_D^{30^\circ}$ of anhydrous derivative is $-79^\circ \cdot 86$ in pyridine (C, 1·2242); by Deninger's method a nonabenzoyl derivative $C_{27}H_{23}O_6(O.Co.C_6H_5)_9, H_2O$, m.p. 141° colourless nodules from hot alcohol, $[\alpha]_D^{30^\circ}$ of anhydrous derivative $= 77^\circ \cdot 20$ in pyridine (C, 2·5250); by the action of *p*-nitrobenzoyl chloride and pyridine, a tetra *p*-nitrobenzoyl derivative, $C_{27}H_{28}, O_{11}$ $(O.Co\ C_6H_4.No_2)_4$, m.p. 154° $[\alpha]_D^{30^\circ} = -44^\circ \cdot 30$ in pyridine (C, 2·8912); by the action of hydroxylamine hydrochloride and anhydrous sodium acetate in ethyl alcohol a mono-oxime $C_{27}H_{32}O_{14}.NOH, 2H_2O$, flakes from hot alcohol, m.p. 180° after shrinking at 165°; with ethyl chlorocarbonate, and pyridine a carbethoxy derivative, m.p. 83–84° after shrinking at 82°.

Acetyl-, benzoyl-, *p*-nitrbenzoyl-, and carbethoxy derivative do not dissolve in cold concentrated alkali, give no colouration either with Mg and methyl alcoholic hydrochloric acid nor with hot or cold concentrated hydrochlroic acid but give with cold concentrated H_2SO_4 orange red, orange, yellow on heating only, bright yellow colouration which changes to orange red on warming, respectively. The oxime gives with concentrated hydrochloric acid a deep yellow colouration changing to orange on heating and orange red with cold concentrated sulphuric acid; and dissolves in alkali to yellow solution.

(1) In hot aqueous solution by the action of lead acetate and subsequent dilution of its cold alcoholic solution with water yields a bright yellow crystalline salt $C_{27}H_{30}O_{13}$ $(O.PbO.COMe)_2, 2H_2O$, m.p. 128° after shrinking at 115°; $(CH_3)S.O_4$ and KOH yield methyl butrin, m.p. 82–84°, deep yellow powder; with C_2H_5I, K_2CO_3 (anhydrous) in ethyl alcohol diethyl butrin, $C_{27}H_{30}O_{13}(OEt)_2$ $\frac{1}{2}H_2O$ a white crystalline stuff, m.p. 238°. It contains the flavanone nucleus and with Mg and methyl alcoholic hydrochloric acid gives reddish violet colouration, pinkish red with concentrated sulphuric acid and none even with hot concentrated hydrochloric acid and from the mother liquor is obtained the isomeric chalkone as bright yellow nodules, m.p. 183° (uncorr.), $C_{27}H_{30}O_{13}(OEt)_2$, $4\frac{1}{2}H_2O$ which loses $3\frac{1}{2}H_2O$ at 120° and gives a yellow colouration with hot concentrated hydrochloric acid. By taking methyl iodide in place of C_2H_5I and crystallizing from boiling water, are obtained tiny needles of *o*-methyl butrin $C_{27}H_{30}O_{30}(OCH_3)_2$, $7\frac{1}{2}\ H_2O$, m.p. 224° (uncorr.) which loses $7H_2O$ at 140°. (I) with H_2O_2 and KOH (16%) 0–5° for 24 hours and subsequent hydrolysis yields Fisetin but the intermediary flavanol glucoside could not be crystallized.

It is concluded that butrin is a bioside and not a di-glucoside but the position of biose residue is still undetermined.

The author wishes to express his indebtedness to Dr. S. Dutt, D.Sc., F.R.S., for his kind interest in the work.

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Allahabad, University,
Allahabad,
October 7, 1936.

Interference of Soil in the Estimation of Furfural.

IN the estimation of furfuraldehyde yield of soil organic matter, manures and of plant materials admixed with soil, it was found that the yield, as determined both by the phloroglucinol method as well as the volumetric bromine method, was seriously lowered by the presence of soil. The percentage recovery of furfural from added plant materials of known composition varied with the nature of the soil and decreased

with an increasing ratio of soil to plant material; at a ratio corresponding to 4 per cent. of organic matter in the soil, the recovery was, in some cases, as low as 50 per cent. A comparison of the behaviour of the soil before and after ignition showed that the interfering effect was not due to the organic constituents of the soil, *e.g.*, lignin, but was due mainly to the inorganic components. In fact, organic fractions such as lignin and tannin, reported by other workers as interfering in the estimation of furfural[1] were found to exert only a slight harmful effect in comparison with the soil inorganic fraction.

A detailed examination of the nature of the interference, by adding known inorganic compounds to plant materials, prior to distillation with 12 per cent. HCl, showed that oxidising agents, such as ferric and manganic compounds, gave low recoveries of furfural. Ferrous and manganous salts were harmless. It was noteworthy that the effect of ferric and manganic compounds on added furfural was much less than that on added plant materials.

A method has been worked out for the correct estimation of the furfural content of organic residues in presence of soil, by a preliminary reduction of ferric and other oxidising compounds present, by the addition of the necessary amount of stannous chloride, and subsequent distillation with 12 per cent. HCl. Full details of the method will be published elsewhere.

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Department of Biochemistry,
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February 2, 1937.

[1] *Ind. Eng. Chem.* (Anal. Edn.), 1934, **6**, 205–08.

Staminodes in *Elatteria cardamomum* Maton.

IN the description of *Elatteria cardamomum* Maton., given in "The Flora of British India" by J. D. Hooker, "Die Naturlischen Pflanzenfamilien" by Engler and Prantl, and in "The Flora of the Presidency of Bombay" by Theodore Cooke, no mention has been made of two staminodes that are found at the base of the corolla tube just at the top of the ovary (Fig. A–2). Including these two staminodes there are six members in the andrœcium: one petaloid staminode—the lip—"Longer than the corolla segments, white sheathed with violet" (Hooker); "two lateral staminodes minute teeth"; one functioning stamen

Fig. 1.

(A) Flower of *Elatteria cardamomum* Maton., with the calyx and corolla tubes cut open at the lower half—1, to show the two staminodes—2, at the base of the corolla tube. (B) The two staminodes at the base of the corolla tube enlarged.

with a short filament and contiguous anther cells; and two staminodes at the base of the corolla tube just at the top of the ovary (Fig. A–2). The two staminodes at the base of the corolla tube have been found also in *Elatteria cardamomum* var. Major Smith.

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November 11, 1936.

A Note on the Development of the Embryo-sac in *Trichosanthes dioica* Roxb.

Trichosanthes dioica is a Cucurbitaceous plant which is commonly grown in Bengal as a vegetable crop for its fruits.

Previous work on the embryology of other Cucurbitaceous plants by Kirkwood[1] and Kratzer[2] has revealed that the development of the embryo-sac in this family is of the normal angiospermous type.

In *Trichosanthes dioica* the nucellus is at first composed of homogeneous cells. Very soon, however, a group of archesporial cells is noted below the epidermis. A single megaspore-mother cell differentiates out from this group of archesporial cells. It always differentiates in the third layer of the nucellar tissue. Due to the rapid division of the wall cells the megaspore-mother cell is pushed considerably inside the nucellus. It next increases in size and becomes elongated. After the completion of the heterotypic division a cell plate divides the cell into two equal halves. The homotypic division very soon follows and a normal linear tetrad of megaspores is produced in every case. The chalazal megaspore functions and by three successive divisions it develops into an 8-nucleate embryo-sac. The mature embryo-sac is of the normal angiospermous type.

The integuments which are two in number, do not come very close in the mature ovule and as a result the micropylar opening is rather wide. The outer integument is massive and consists of several layers of cells, while the inner integument as a rule consists of two layers of cells only.

I. BANERJI.
M. C. DAS.

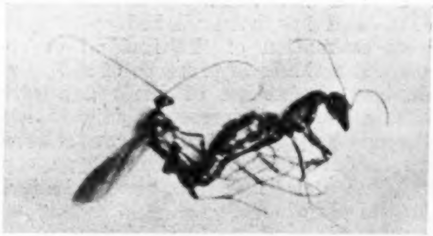
Department of Botany,
Calcutta University,
January 13, 1937.

[1] Kirkwood, J. E., *Bull. N. Y. Bot. Gard.*, 1905, **3**, 313-402.

[2] Kratzer, J., *Flora*, 1918, **110**, 275-343.

Nuptial Relation of *Diacamma vagans*, Smith.

THE females of the genus *Diacamma* are unknown[1] and so far no one seems to have mentioned it as having discovered. Wheeler (1910) is of opinion that the female function of *Diacamma* has probably been usurped by the gynæcoid workers as in certain Ponerine ants.[2] For some time I myself have been in search of females of *Diacamma vagans* and wherever I have come across formicaries I have excavated them but all in vain. In most of these colonies two or three males along with a number of workers only are found. The latter possess receptaculum seminis and ovarian tubules which led me to investigate if the queen phase of *D. vagans* has actually been supplanted by gynæcoid workers,[3] as also to see what rôle has the male to play in the life-history of the species. For this purpose I reared the workers in different artificial formicaries having diet regulating arrangement. One of these formicaries, the inmates of which were poorly fed, was soon found to be the haunting ground of a male of the species which flew to it from outside. The male was welcome. It was being caressed and carried hither and thither by the workers of the colony. After some time the male was observed in the act of mating with a worker, the posterior half of the former's abdomen having been inserted into that of the latter. The male by bending its abdomen was resting upon the back of the worker making itself erect at intervals. I caught hold of them in that position and to prevent the male from detaching itself from its mate I chloroformed the latter to bring about a sudden contraction of its sexual organ. The male also was then killed, and the specimens have been preserved carefully in that state. Their photographs *in situ* are reproduced here.



Mating of *D. vagans* × 2.
Left—Male. *Right*—Female.

Such a case of actual mating has, to my knowledge, not been reported before.[4] If gynæcoid "is a physiological rather than a morphological phase"[5] it evidently does not admit of the sexual act.

G. BHATTACHARYA.

Bose Institute,
Calcutta,
January 25, 1937.

[1] Bingham, C., "Formicidæ," *Faun. Brit. Ind.*, (Hymn), 1903, **2**, 76.

[2] Wheeler, W., *Ants. N. Y.*, 1910, **243**; *Ibid.*, pp. 97, 113, 243, 266, 527.

[3] Wasmann, E., *Mitth. Schweiz. Ent. Gesell.*, **2**, 1904, 67-70.

[4] Wheeler, W., p. 40.

[5] Imms, A., *Text-book of Entomology*, Lond., 1934, 588; Wheeler, p. 97.

A Case of Polyembryony in the Nyctaginaceæ.

An example of polyembryony has been observed in *Bœrhaavia repanda* Willd. A photograph of the preparation showing this condition is reproduced below. The accessory embryo is seen to develop from a synergid.

There are two conditions which seem to be responsible for this kind of development, the occurrence of egg-like synergids and the penetration of accessory pollen-tubes into an embryo-sac. During the course of the investigations going on in this department on the embryology of the flowering plants, both of these conditions have been noted quite frequently in several families of the Centrospermales. It could, therefore, be anticipated that in some cases the simultaneous presence of these characters would lead to the development of polyembryony.

In the Nyctaginaceæ, the presence of accessory pollen-tubes has been recorded both in *Bœrhaavia diffusa*[1] and *B. repanda*.[2] Two pollen-tubes were also seen penetrating the ovule showing polyembryony and figured here. The presence of egg-like synergids has been seen in *B. diffusa*.[3] In *B. repanda*, the material of pre-fertilisation has not been examined, but as the two species are very similar in all their embryological features, egg-like synergids are likely to occur in this species as well. The vacuolation of the basal cells of both the embryos from the polyembryonous ovule is seen to be egg-like. It can, therefore, be concluded that the polyembryony in *B. repanda* has most probably developed from the fertilisation of an egg-like synergid by a male gamete from an accessory pollen-tube in addition to normal fertilisation.

In the family Nyctaginaceæ, no other instance of polyembryony has been recorded so far.

The writer takes this opportunity to thank Prof. A. C. Joshi for his help in the preparation of this note.

L. B. Kajale.

Department of Botany,
Benares Hindu University,
January 25, 1937.

[1] Observed by Maheshwari, *Jour. Ind. Bot. Soc.*, 1929, and the writer.
[2] Observed by the writer.
[3] Observed by the writer.

On a Cymothoan Parasitic on Some Brackish-Water Fishes from Madras.

Several species of Cymothoa (Order Isopoda) are known to inhabit the mouth and gill chambers of fishes, but most of the known species are marine. The well-known fresh-water representatives are *Cymothoa amurensis* Gerst. parasitic on *Cyprinus lacustris* from the river Amur, in Eastern Asia, and *C. henseli* on *Geophagus* sp. from Rio Cadia in Brazil.[1] *Cymothoa indica* Schiödte and Meinert,[2] first described from Bangkok, Siam, has been recorded by Chilton[3] from the Chilka Lake, where it is stated to be " not uncommon in the mouth of the large goby *Glossogobius giuris*, where the parasite causes a deformation of the tongue ". A species of parasitic Isopod was frequently noticed by us in certain species of fishes collected from the Adyar backwaters during the last three years.

The parasites belong to the genus *Cymothoa* Fabr. characterised by the presence of the large abdominal shield, antennæ widely separate at their origin, and other important features. The large ovigerous females agree with the description and figures of *C. indica* given by Nierstrasz in his account of the Isopods of the Siboga collections.[4] The largest specimens (ovigerous females) obtained by us measure 19 mm. long and 9 mm. wide at the broadest part, while the smallest individual is 3 mm. long and 1 mm. wide. The body is long and oval in the large females. As

in other species of *Cymothoa*, the abdominal region is sharply contracted as compared to the rest of the body. The eyes are situated on the sides of the anterior margin of the head; they are large and distinct in the young specimens but become progressively indistinct with increase in size, and in the very large individuals with brood pouches, the eyes are scarcely distinguishable. The same observation is made by Chilton for specimens from Chilka Lake. Judged from the structure of the eyes of young individuals, they definitely appear to be functional during early life, but, as suggested by Eggert,[5] undergo degeneration with increase in age as a result of the peculiar habit of the adult. At Adyar, the parasites have been taken from the mouth and gill chambers of two Chiclid Fish *Etroplus maculatus* and *E. suratensis*, and the goby *Glossogobius giuris*. The number of fish examined, and of those infected are given in the following table :—

Host species	No. of specimens examined	No. of specimens with parasites
Etroplus maculatus ..	54	42
Etroplus suratensis ..	12	6
Glossogobius giuris ..	6	3

It would be seen from the table that the percentage of infection is much higher in *Etroplus maculatus* than in that of the other two species. Though several other species of fish collected from the Adyar have been examined by us, this parasite has been so far observed only in the three species noted above. In each fish, two parasites are normally found, of which one is the large Ovigerous female found in the mouth, and the other, the smaller and more active male usually observed on the gills. Females with embryos have been collected during different months of the years; the number of embryos in the brood pouch normally varies from 30 to 90.

The species of *Cymothoa* commonly met with in India are all from marine fishes. *Etroplus maculatus* and *E. suratensis* are commonly found in fresh- and brackish-water, but are not known to enter the sea. *Glossogobius giuris* is found in sea, brackish- and fresh-water. We have found the Cymothoans on the above fishes collected from the Adyar backwaters where the salinity is fairly high (18 to 30 per mille) as well as from about four miles up the river where the water is practically fresh.

N. KESAVA PANIKKAR.
R. GOPALA AIYAR.

University Zoological Laboratory,
Madras,
January 23, 1937.

[1] Gerstacker, A., and Ortmann, A. E., "Die Klassen und Ordnungen der Arthropoden," in Bronn's *Klassen und Ordnungen des Their-Reichs*, 1901, **Bd 5**, Abt. II. *Crustacea*, Hft. Malacostraca, Leipzig.

[2] Schiödte, J. C., and Meinert, Fr., *Naturhist. Tidsskr.*, 1884, **4**, Ser. 3, p. 221, Kopenhagen.

[3] Chilton, Chas., *Mem. Ind. Mus.*, Calcutta, 1924, **5**, 875.

[4] Nierstrasz, H. F., *Siboga Expeditie*, 1931, XXXII c, p. 123, Leiden.

[5] Eggert, Bruno, *Zool. Anz.*, 1927, **Bd. 73**, (1/2), 33, Leipzig.

A New Easy and Inexpensive Method for Taking Photomicrographs.

FROM year to year the markets are flooded with the most modern apparatus for photomicrography and those laboratories which possess the old apparatus and have no funds to purchase the latest novelty are supposed to be handicapped. The trade depression of firms like E. Leitz, Wetzlar & Zeiss, Jena, stimulates the production of new apparatus. Many instruments with but slight changes and most fascinating advertisements are introduced every year into the markets and one requires a huge fortune to renew the old apparatus of a laboratory. Many different kinds of appliances have been invented for photomicrography recently, but, every one cannot handle these with success without a thorough training and experience.

A very simple and inexpensive method for taking photomicrographs is described in this paper. All that is required is (1) a Leitz Monla lamp with regulating transformer, (2) a Microscope and (3) an Abbe's prism. The Leitz Monla lamp may be replaced by an electric table-lamp with 100 Watt bulb and a long opaque shade. A Leitz Monla lamp is preferred because it may be overloaded up to 6 amperes without risk of blowing, and lights up immediately the current is switched on. On account of the concentrated form of the

radiant surface, as well as the overload which the filaments will bear, this lamp furnishes the highest lighting effect which is attainable with any filament lamp. The lamp bulb is enclosed in a casing furnished with a slit for the reception of a ground-glass screen. The lamp lens, which is specially designed for use with filament lamps, has a helical focussing motion.

The arrangement is depicted in Fig. 1, installed in a dark-room with a ruby lamp over it. The image of the object desired to be photographed is focussed on a white sheet of paper. The lamp is switched off and the paper is replaced by a printing-paper. In order to cut off the extra light, the lamp

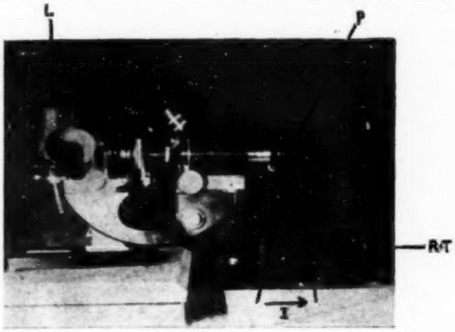


Fig. 1.

L. Leitz Mola Lamp. R.T. Regulating Transformer.
P. Abbé's Prism I Image of the object.

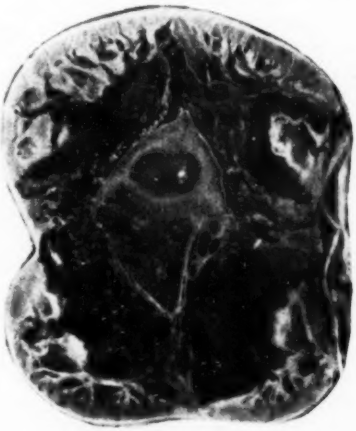


Fig. 2.

Direct impression of the object on the printing-paper (A negative picture).

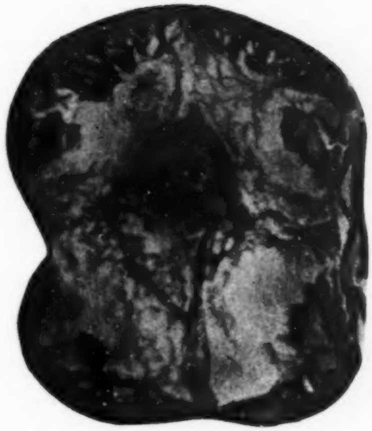


Fig. 3.

A positive print of the same object as in Fig. 2.

and microscope are covered by means of a thick black cloth. It is recommended that Agfa Brovira Hard papers be used. With the full intensity of the Monla lamp, only a second's exposure is enough to get the impression. Fig. 2 represents the photomicrograph taken by a direct exposure on the printing-paper, while Fig. 3, is a positive picture of the same object taken by Leitz Leica Camera. A direct impression is recommended for histological preparations, specially for showing the nervous structures. It is only a convention that the nucleus be shown as a darkly stained body and this convention can be set aside in favour of saving time, labour and expenses.

If the negative prints are not desired then the impression could be taken on a process plate of a slow speed and the intensity of light can easily be controlled in order to give the right exposure. This eliminates the expenses of purchasing a camera for photomicrography.

In taking a direct impression on printing-paper, the cost would be about one anna and three pies per quarter size picture and plenty of time and labour is saved thereby. On the contrary, positive prints would cost not only time and labour but also five annas and three pies per picture if taken according to the method described above.

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Zoological Laboratories,
Muslim University,
Aligarh, U. P.

REVIEWS.

Magnetochemie. By Dr. Wilhelm Klemm. (Akademische Verlagsgesellschaft M. B. H., Leipzig), 1936. Pp. 262. Price 16 R.M.

The importance of magnetic measurements in dealing with chemical problems can be gauged from the fact that within a year of the appearance of the first book in English on the subject of Magnetochemistry by S. S. Bhatnagar and K. N. Mathur (Macmillan & Co.), Dr. Wilhelm Klemm, Professor of the Techn. Hochschule Danzig-Langfuhr, has brought out a German monograph entitled *Magnetochemie*. The book covers a wide and varied field. The earlier chapters are devoted to general physical principles and methods of measurements. The treatment is satisfactory, and nearly everything of importance has been dealt with. The author has made a slip in ignoring altogether the large electro-magnet of Cotton and, while describing the methods of measurements, such important contributions as those of Bauer and Piccard, Wilson, Oxley, Bitter and several others may have been taken into consideration. There is a very good discussion of older theoretical results. A very reasoned criticism of the Langevin and Weiss theories leads on to the more modern concepts of magnetism based on the old and new quantum mechanics. Of particular interest are the accounts of the influence of temperature and the chemical linkage on the permanent moments, and the chapters on the magnetic properties of atoms and ions which deal fully with the theoretical methods of Kirkwood, Pauling, Hartree, Stoner, Slater, Angus and others.

Part III deals particularly with the application of magnetic properties to chemical problems, such as the determination of constitution as suggested by Pascal from susceptibility considerations and by Perkin and others from mangeto-optical and molecular refraction measurements.

Diamagnetism and polymerisation, free radical paramagnetism, compounds of rare earths, complexes both normal and penetration, rules of Sidgwick and Bose, the theories of Pauling and Van Vleck, the influence of crystal sturcture on magnetic properties, magnetism of elements and solid solutions have been treated in a systematic though reasonably brief manner. A particular feature of the book is the space devoted to the discussion of the intermetallic phases from the magnetic concept and the alloys so important in industry find special mention. The author is fully alive to the importance of magnetic measurements for analytical purposes and for other uses such as the separation of substances and in chemical kinetics. The book is a very useful addition to the literature on the subject of Magnetism and Chemistry and will no doubt attract the attention of research-workers in this field.

S. S. B.

Tables Annuelles de Constantes et Données Numériques de Chemie, Physique, Biologie et Technologie.—[Guthier-Villars (Paris); McGraw-Hill Book Co., Inc. (New York).] (1) *Numerical Data on Radioactivity, Nuclear Physics, Transmutations, Neutrons and Positrons*: (1931 to April 1936). By I. Juliot-Curie, B. Grinberg and R. J. Walen. Pp. 57. Price 8*s*.

Workers in the field of Nuclear Physics will gladly welcome the appearance of this section of the Annual Tables which is literally a treasure-house of information invaluable alike to the experimenter as well as to the theorist, on a branch of Physics which has had a phenomenal growth and has assumed considerable proportions during the last five years. As we are all aware, the rapid succession of discoveries in the field of Radioactivity and Nuclear Disintegration which this period has witnessed has led and is leading to results of far-reaching and fundamental significance relating to basic problems such as the Structure of the Atomic Nucleus, the Nature of Radiant Energy, the inter-relation between Energy and Mass and the validity of the hitherto-undisputed Conservation Laws of Nature. The brilliant part played by the Curies in the unfolding of this new knowledge can hardly be overstressed. The literature on the subjects embraced by the fascicle under review has grown with such rapidity and is scattered

over so many journals that we cannot be adequately thankful to the publishers in general and to the authors in particular for making it all so readily accessible to a wide circle of interested workers through the medium of the present publication.

The subject-matter is divided into two main sections. Section A deals with Natural Radioactivity under eight appropriate headings. Starting from the half-value periods of the naturally occurring radioactive elements the tables give exhaustive data concerning the spectra, energies, ionisation, range, slowing-down, and scattering by nuclei of α-rays. This is followed by the spectra and energies of β-rays and the spectra and absorption of γ-rays respectively. An account of the distribution of energy between the radiations emitted by radioactive elements, the chemical effects of these radiations and a list of the radioactive minerals and springs found in different parts of the world bring Section A to a close. Section B which occupies the greater part of the space gives first of all a systematic, complete and critical account of the numerical data relative to Transmutations and Induced Radioactivity. In presenting these data, the authors have classified the 92 known elements into two groups. As they have pointed out, the first thirty elements have been studied in great detail and a great many transmutations have been observed in these cases. Transmutations in the case of the remaining elements have been definitely established only when they are bombarded by neutrons, and in all these cases the resulting elements are found to be radioactive. The bibliography on transmutations shows at once the importance of the subject as well as the interest which it has evoked when one glances over the rapidly increasing number of publications year after year. Interesting and valuable data relating to Protons, Isotopes, Neutrons and Positrons are contained in the last few pages. We have little doubt that the fine get-up, clarity and completeness of the compilation combined with the low price of the fascicle will ensure for it a considerable demand.

(2) *Numerical Data on the Raman Effect: Spectra, Intensities and Vibration Patterns*: (1931 to 1934). By Dr. M. Magat. Pp. 112. Price 12*s*.

The importance of the information furnished by the study of the Raman Effect to workers in the field of Molecular Spectra and allied fields of physical and physico-chemical research needs no special emphasis. Dr. Magat has therefore fulfilled a task of great service to physicists and chemists at large by his careful and painstaking compilation and classification of the vast expanse of numerical data collected on the Raman Effect between the years 1931 and 1934. The substances are grouped according to their chemical constitution, the inorganic compounds being treated first, and the more numerous organic compounds in the second part. As Dr. Magat has emphasised, some difficulty is experienced in assessing the relative intensities of the Raman lines in a tabulation such as the one under review, since the visual intensity estimates generally given by investigators are only of an empirical and qualitative nature based on arbitrary standards.

The appendix at the end of the book which gives the vibrational modes, degeneracy, selection rules and polarisation characters of the Raman lines of typical molecules possessing certain symmetry elements adds greatly to its usefulness. Certain minor errors in this section which require correction might be pointed out. In Fig. 5, p. 103, which gives the normal modes of vibration of the AB_3 molecule, the diagrammatic representation of ν_σ is incorrect. For infinitesimal vibrations, the conservation of angular momentum demands that the motion of the B atoms should be along the sides of the triangle instead of being inclined to them as represented in the figure. In Fig. 15, p. 105 which represents the normal vibrations of the tetrahedral AB_4 model, the doubly degenerate mode ν_4 is incorrectly represented since the central atom is at rest in this vibration. It need scarcely be added that as a source of quick and ready reference the book will be of great help to workers engaged in the elucidation of molecular structure and constitution of chemical compounds.

A word of explanation is perhaps necessary for a publication such as the present one which deals only with the results obtained till the end of 1934 on a subject which is drawing forth an endless stream of research papers from day to day. We understand that it is part of the programme laid out by the Managing Committee to bring out in this and similar other cases supplementary

fascicles embodying the data obtained during the period 1935–1936. The fulfilment of this programme in 1937 will be awaited with great interest.

(3) *Numerical Data on Rotatory Power*: (1931 to 1934). By E. Darmois, Pp. 68. Price 8*s*.

This is essentially a well-arranged tabulation of the experimental results that have accumulated on the subject of Optical Rotatory Power between the years 1931 to 1934. The specific rotatory power of various groups of substances in the homogeneous state and in solution and the influence of temperature, concentration and solvent on the rotatory power are considered first. Exhaustive data relative to Rotatory Dispersion, Resolution of Racemic Compounds and Mutarotation which follow next occupy some forty pages. A short section on the influence of various additions on the optical rotatory power, and a final one which gives references to select original papers that are more or less of a theoretical nature on topics such as the Walden Inversion, Configuration Studies, Absorption and Rotatory Power, Optical Superposition and Asymmetric Synthesis are also added. The detailed bibliography at the end gives references to some 400 original papers that have appeared on the subject in the period covered by the tables.

R. ANANTHAKRISHNAN.

The Aromatic Diazo Compounds and Their Technical Applications. By K. H. Saunders. (Edward Arnold & Co., London), 1936. Pp. xii + 224. Price 12*s*. 6*d*.

The peculiar properties of the diazo compounds render them very valuable both to the manufacturer of dyestuffs and chemicals on a large scale and the chemist engaged in research. Since the publication of the second edition of Cain's book *Chemistry and Technology of the Diazo Compounds* appeared about two decades ago, and since in the interval, great advances in the chemistry and technical applications of this group of compounds have taken place, the present book supplies a definite need. It gives a clear and concise account of the subject up to date and in spite of its larger scope the size has not been unduly increased. Appropriate to the title, the consideration of the aliphatic diazo compounds has been omitted. By judiciously limiting the space allotted for the discussions of theories, the author has given due prominence to the descriptions of the reactions. The theoretical portion, instead of being an indiscriminate compilation of all and sundry ideas, gives a critical and well-thought-out review of the important developments. The book will be a very useful addition to any scientific and technical library.

T. R. SESHADRI.

Kurzgefasstes Lehrbuch der Physiologischen Chemie. By S. Edlbacher. (Walter de Gruyter & Co., Berlin and Leipzig), 1936. 3rd Edition. Pages 286. R.M. 8·50.

The book is essentially for students going in for a degree course in medicine and as such it fulfils the purpose admirably. The arrangement of the subject-matter follows the usual sequence found in the books on the subject. The book is indeed remarkable for the lucidity of expression. The author has succeeded in presenting some difficult aspects of the subject, *e.g.*, the stereochemistry of amino-acids, the chemistry of proteins, etc., in a manner so as to be comprehensible even to a student possessing something less than an average intelligence. The subject-matter has been brought up-to-date which in itself is no mean achievement for a "Kurzgefasstes Lehrbuch". Some printers' errors, however, have been overlooked, *e.g.*, an O-atom has been left out in the formula of β-glucoside (p. 14), "Carboxyl" for Carbonyl and "Joung" for Young are in the text, which will, I hope, be rectified in the next edition.

V. N. PATWARDHAN.

Manual of Pharmacology. By W. E. Dixon. Revised by Dr. W. A. M. Smart. (Messrs. Edward Arnold and Co., London), 8th Edition, 1936. Pp. 483. Price 18*s*. net.

The *Manual of Pharmacology* by Professor W. E. Dixon is one of the most popular textbooks on the subject and the appearance of a new edition after an interval of seven years will be welcomed by both teachers and medical students. With the development of improved experimental methods and laboratory technique, pharmacology has made a remarkable progress during recent years. It was only natural, therefore, that in order to include all the newer knowledge a number of sections in the new edition should be rearranged and recast. This task has been very effectively and successfully carried out

by Dr. Smart. Although at first sight the book may appear to be a new one and not a new edition, careful perusal gives ample evidence of the personality of the old master.

The introduction of chemical formulæ and the attempt to bring into prominence the relationship between chemical constitution and pharmacological action are features evident to the most casual reader. Another innovation is the addition of a classified list of materia medica at the end of each chapter. A number of chapters, *e.g.*, hypnotics, uterine drugs, respiratory drugs, etc., have been thoroughly rewritten and brought up-to-date. The newer conceptions with regard to nature of action of eserine and cholinergic drugs have been included. Classification and arrangement of the subject-matter appears to have been done with great care and number of useful tracings have also been added.

The book is bound to create a very favourable impression and one may confidently hope that this edition would continue to maintain the useful purpose which its predecessors did for over a couple of decades.

R. N. Chopra.

The Microscope. By Simon Henry Gage. (Comstock Publishing Company, Ithaca, New York), Sixteenth Edition, 1936. Pp. viii + 616. Price $ 4 net.

This revised and greatly enlarged edition of Professor Gage's work will be invaluable to beginners and advanced students of biological laboratory practice. The book deals in a simple and direct language with the general principles of microscopy, profusely illustrated by well-chosen figures. The methods of latest technique for the preparation of material for microscopic examination are fully treated and the needs of research workers receive ample consideration. Chapters III, VI and XIV, which treat of dark-field microscopy and its application, the ultra-violet microscope and physical analysis and micro-incinerations and the optical applications for their examination respectively, are full of interest. As an aid in resolution, the dark-field microscope has a greater advantage over bright-field illumination, by the absence of glare and flooding, the whole aperture of the objective being filled by uniform light. Objects which are not sufficiently clearly resolved by transmitted illumination can be resolved by dark-field illumination with greater precision. Many useful hints regarding condensers, cover slips, lighting and lamps, preparations of objects are given in Chapter III. The ultra-violet microscope is a valuable aid in the physical analysis of objects under examination, and it is becoming increasingly necessary for acquiring as complete and detailed a knowledge of the structure and function of the tissues as the light radiations and lenses permit. Chapter VII gives an account of the general principles of the ultra-violet microscope and directions for its use in the examination of microscopic preparations. The chapter on Micro-incinerations gives the method by which the mineral salts in the fixed tissues can be studied, together with a detailed account of the optical appliances for such study. From the nature of the material, a dark field is almost a necessity for the study of the ash after micro-incineration and the special apparatus employed in the investigation include Policard-Scott Micro-incinerator, and uranium glass for showing the form and path of light beams.

Each chapter concludes with a list of reference works for collateral reading and the whole book is profusely illustrated. The final chapter gives a brief history of lenses and microscopes.

This sumptuous book is indispensable to biological students and research workers, and is an extremely important contribution to the theory and practice of microscopy.

Rutley's Elements of Mineralogy. By H. H. Read, (Thomas Murby & Co., London), 1936. 4th Edition. Pages viii + 490 + 12. Price 8*s*.

This is the fourth edition of Rutley's *Mineralogy* which has appeared under the editorship of Professor Read since 1915. This edition has been so completely rewritten and re-arranged that it is difficult to find any resemblance to Rutley's original *Mineralogy*, but the courtesy title remains in admirable memory of that great mineralogist.

The needs of the student, and especially of those who will be more interested in the economic side of mineralogy, are kept constantly in view throughout. The book commences with a description of those chemical

properties by which minerals may be identified; these are, of course, the usual blowpipe tests which it is believed, all good prospectors should know. Some day, perhaps, a text-book on mineralogy will appear describing those micro-chemical tests on which minearls can be so simply and rapidly determined even by the most junior of students. The reader is led in Chapetr II through the various macroscopic properties which aid in mineral diagnosis—logically, perhaps, this second chapter should be first, but Professor Read's arrangement is essential as mineralogy is founded on the principles of chemistry. A reference in this second chapter to the ease with which hardness and cohesion may be confused would be desirable—the true hardness of a mineral is often far greater than its apparent hardness, hematite and pyrolusite being apposite examples. In Chapter III the elements of crystallography are simply and clearly told in sufficient detail, perhaps, for the elementary student. However, this reviewer would have liked to see this section treated even more fully, for crystallography is the most important branch of macroscopic mineralogy; in other respects mineralogy has gone far beyond the study of hand specimens. The microscope is now the most powerful weapon of attack; microchemical tests and the determination of refractive indices have become the foundation of diagnostic mineralogy. A brief note on the use of X-rays in crystallography might have been usefully inserted. Mineral optics receives excellent treatment, particularly as its practical application in determinative mineralogy is so well brought out and stressed. The uses of the petrological microscope are outlined and a few words are said about the reflecting microscope. Part I closes with a chapter on the mode of occurrence of minerals, completing a clear picture for the student of the place of minerals in nature.

Part II is entirely devoted to the description of minerals. The classification adopted is quite new, the economic significance of mineralogy being further emphasised by arranging the minerals primarily according to the useful elements present in them, and grouping them in the order of the Periodic Classification. Only the more important minerals are described; some of us may not agree as to which are the most important! The mode of occurrence and uses of each mineral are briefly sketched, a most excellent feature of the book. In some cases production statistics are given for recent years, helping the student to a clearer conception of the mineral industry. Some of Professor Read's descriptions of the mode of occurrence of certain minerals may not be acceptable to many economic geologists to-day; one example is his reference to certain copper deposits which he classifies as pneumatolytic and pyrometasomatic. A few of the descriptions suggest that Professor Read has not entirely kept up to date in his reading of the literature. It is a little depressing to the microscopic mineralogist to see limonite still described as a mineral with the formula $2Fe_2O_3\ 3H_2O$, to note the absence of any reference to water adsorption in the variety of hematite known as turgite, and to read that pyrrhotite often contains nickel and cobalt. This reviewer has found, at least in India, that misconceptions such as this, once acquired by a student, are very difficult to eradicate even when he becomes a graduate. An idea of microscopic inclusions and intergrowths should be given clearly in even elementary text-books, and it should be stated that such materials as titano-magnetite are mixtures and not minerals. However, there is apparently a long way to go before English mineralogy begins to appreciate the significance of ore-microscopy. Notwithstanding such occasional defects in precision this reviewer is of the opinion that Professor Read's latest edition of Rutley's *Elements of Mineralogy* is the finest text-book of elementary mineralogy which has yet appeared and is certainly the most suitable for the needs of students in India.

J. A. Dunn.

Historical Introduction to Chemistry. By T. M. Lowry. (Macmillan & Co., Ltd., London), 1936. Pp. ix + 581. Price 10*sh*. 6*d*.

This is the second edition of the late Prof. Lowry's well-known book, the first edition of which appeared in 1915. All the material included in the earlier edition has been preserved intact. In addition, a brief mention has been made of modern work on isotopes, the elements, hafnium and ilinium, etc.

The book provides within a reasonable compass an excellent introduction to historical chemistry.

M. Seshaiyengar.

Soil Erosion and its Control.

[*Soil Erosion and its Control* by Q. C. Ayres. (McGraw-Hill Publishing Co., New York and London), 1936. Pp. 365. Price 21*sh*.]

THE attention of the whole American nation has within the last 3 years been concentrated upon the disastrous effects of disforestation and careless field cultivation in destroying the fertility and dispersing the substance of their soil. Years of propaganda and small-scale demonstrations carried out by a small band of far-seeing enthusiasts has suddenly borne fruit in the creation of a vast federal government organisation, the Soil Conservation Service, which in an amazingly short time has established big demonstration projects in practically every state. These projects are staffed by men who have had previous experience on the land and some special training in soil conservation or counter-erosion work, the original cadre being mostly recruited from the forest service and from agricultural engineers.

These activities have resulted in a vast output of printed matter, mostly publicity pamphlets, newspaper articles, addresses to learned societies, leaflets and bulletins to farmers, etc., but the men who could have written a comprehensive text-book on the subject were all much too busy organising new developments, which reminds one of the quip: "An American acts then thinks, an Englishman thinks then acts, and a Chinaman thinks, and goes on thinking!"

Many of the American universities and State colleges have extended their forestry and agriculture courses to provide for the training of this new army of soil conservation workers, and the book under review is a students' text-book written by the Professor of Agricultural Engineering in the Iowa State College at Ames, Iowa. This State is in the northern half of the Middle West farm belt with a rainfall of about 30 inches with light soils and very gentle gradients, in fact ideal country for wheat farming, but its productivity has been very seriously reduced by wasteful farming methods, which have allowed the valuable top-soil to be washed away into the Mississippi River. Professor Ayres' book gives an excellent general account of the erosion situation in the United States and ably summarises the mass of scattered literature which has already been printed, but the bulk of the book consists of detailed recommendations for the construction of field terrace and soil-saving dams which in pattern, scale, and labour methods are not directly applicable to Indian conditions.

A short introduction is devoted to object lessons from erosion already reported from other countries, but this might have been made much fuller and more convincing in view of the world-wide attention which is now being directed to this subject. China, of course, is the great historic instance of utter impoverishment and denudation which followed the destruction of her northern highland forests, but within recent years fresh material from archæological research has proved more or less conclusively that the great Aztec civilisation of Central America passed away as a direct result of desiccation and erosion following upon clearance of tropical jungle on a big scale. India itself provides many concrete instances, such as Alexander's historian's report of great stretches of forest between Jhelum and Peshawar, and the Moghal historian's account of the siege of Nurpur, Kangra, carried on "in forests so dense that a bird could scarce stretch its wings," where now there is hardly a tree for a bird to nest in. Many of the African colonies are taking up erosion control on a considerable scale and Australia is also starting, though much damage already done is irrepairable.

In his discussion of the causes and effects of denudation of the existing plant cover as a contributory factor in erosion, the author brings out clearly the relative value of the various farm crops. He shows that soil loss is in direct ratio with the number of days for which a field is left with its soil surface uncovered by any crop—for instance continuous corn (maize) with 207 days of uncovered soil is highly destructive, continuous wheat with 91 days finds a midway position, while a permanent sward of fodder grass is a real guarantee against erosion. In discussing the influence of forest cover, however, he is not so convincing; for instance he quotes figures from a mountain forest study by Bates and Henry at Wagonwheel Gap, Colorado, where the run-off of water and solid eroded material was measured from two comparable catchments, one of which was clear-felled. The figures showed an appreciable increase in erosion, but not to any spectacular amount. This is quoted as an example of "denudation,"

but actually the forest area felled was kept closed to grazing and recovered so quickly by the sprouting of aspen coppice shoots, that after only a few weeks' real exposure to the elements, the whole area was reclothed even more densely than before. The usual Indian conception of "denudation" entails the complete and permanent eradication of the natural plant cover through browsing and grazing, as well as felling of the trees, but Bates and Henry's figures are for a much less drastic operation and are therefore not a true picture of the amount of destruction actually wrought by complete denudation as we conceive it.

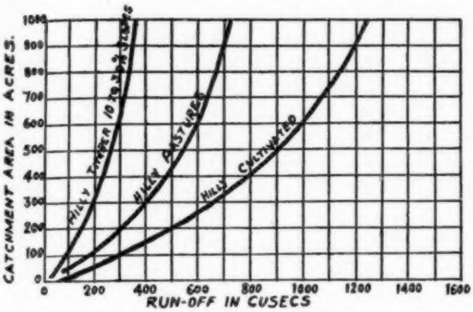
One method of reducing erosion from field crops which has been much taken up in the United States is strip cropping, *i.e.*, growing different crops in strips along the contour so that the cumulative surface wash from a very vulnerable crop can be reduced. Cotton, maize, tobacco and other clean-tilled crops expose the soil beneath them, but loss of soil incurred by growing these can to some extent be prevented by interspersing strips of clover, lucerne, charri and other serghums, wheat, barley, oats, fodder grasses or any other crop which makes a fairly good protective cover. In Indian practice it is of course essential that to be effective these must be fully established and in plentiful leaf before the onslaught of the monsoon rains, for it is then that protection of the soil is so essential. The Americans have experimented and measured every imaginable combination of crops suitable for each of their climatic regions in order to ascertain which gives most protection for a maximum area of cash-producing crops. The lesson should be applied in India, but a special technique suitable for our very small fields will have to be worked out; the usual Indian closely terraced rice fields probably are unbeatable for preventing run-off, but other crops on sloping lands leave much to be desired. Improvement along this line will have to provide for popularising cut-fodder crops because these are amongst the best soil protectors.

The use of contour-terracing either of stone or turf walls or ploughed earth ridges (the latter known in the Punjab as *watt bandi*) is already well known in many parts of India, though unfortunately it is not sufficiently practised. The use of the American broad-based terrace which does not interfere with ploughing is excellent where big single fields of uniform slope have to be broken up into smaller catchment units, but is not generally applicable in Indian field crops. It should however prove of very great value in the improvement of gently sloping grazing grounds; the response of grass to the extra share of moisture caught and held by such broad-based terraces is most marked, and if only some of our village grazing grounds on gentle slopes could be closed to grazing and contour-ridged for growing cut-fodder, the gain both in reducing run-off and in conserving cattle food would be considerable. The author advocates contour-ridging in pasture land, but he has omitted a very necessary note of warning, namely, that for ground open to heavy grazing contour-ridging on anything more than very gentle slopes, of say 1 in 10, is bound to lead to concentration of run-off and consequent erosion.

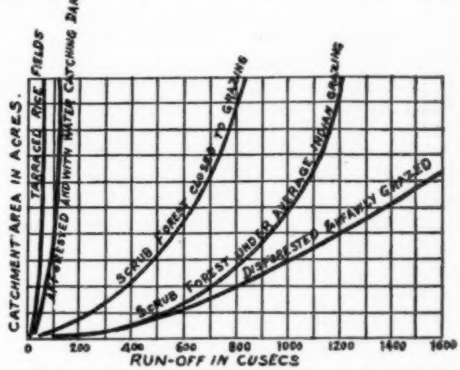
Probably the most useful section of the book for Indian practice is that on the planning and construction of soil-saving and water-catching dams. In Gurgaon and many other waterless tracts of isolated low hills there is a great future for water-catching dams of earth or stone, but they must be well placed and scientifically constructed, especially as regards the escape channel for leading away the surplus water when it threatens to overflow. Useful tables are given for calculating the size of such dams and their outlets, based upon the expected maximum run-off from serious storms. The actual figures for run-off for different slopes and types of plant cover are copied from C. E. Ramser's well-known data, now in common use amongst American soil conservation workers. These would need to be used with great caution if applied to Indian conditions, firstly, because individual storms in India will exceed even the semi-tropic south-eastern region of the United States in concentrated intensity and in cumulative heaviness. Secondly because Ramser's graphs show pasture land as giving considerably less run-off per acre than cultivated ground on a similar slope; in India it is generally the reverse, partially terraced cultivation giving decidedly less run-off than grazing ground of the same slope. This epitomises the essential difference in conditions between the two countries; in the United States cultivation is in big fields so that long unbroken slopes of bare plough land give much heavier run-off than do the comparatively well clothed

pasture fields grazed in a rational manner, generally on a definite rotation. In India, on the other hand, small individual holdings mean small individual fields, generally terraced to some extent, while adjoining

graph giving his empirical figures of run-off for different sizes of catchments of from 10 to 30 % slopes is reproduced alongside



Ramser's curves for average American conditions giving maximum expected to be exceeded once every 10 years.



Similar curves for Indian conditions based on very meagre Punjab Foot Hill Data.

Fig. 1.

Comparative run-off for American and Punjab conditions.

grazing ground is so persistently overgrazed that it is left completely exposed to sheet erosion.

To make this position clear, Ramser's similar curves for Indian conditions, though our information for the latter is unfortunately very meagre.

R. MACLAGAN GORRIE.

OBITUARY.

Mr. Dev Dev Mukerji (1903–1937).

WITH deep regret we record the death of Dev Dev Mukerji, Technical Assistant in the Zoological Survey of India, which took place at Calcutta on Thursday, the 21st of January 1937, after a brief illness, at an early age of 34 years.

Dev Dev Mukerji was born in January 1903 at Kharda in the 24-Parganas and after his early education at the village school he was sent to H. C. E. School at Andul from where he passed his Matriculation Examination. In 1919, he joined the St. Xavier's College at Calcutta and four years later passed his B.Sc. Examination with honours in Zoology. In 1925 he took his M.Sc. degree of the Calcutta University in Zoology, and in 1926 joined as an Assistant in the Zoological Survey of India.

Mukerji had a special aptitude for research and a year after his joining the Zoological Survey he published his first paper on two "Pug-headed" specimens of a catfish. Afterwards he worked on several collections from different parts of India in collaboration with the officers of the Department or independently. He was also a keen field zoologist, as is clear from some of his papers.

Mukerji was very methodical, thorough and painstaking in his work and made a very critical study of the data he collected. His published papers show what a commendable amount of research work, besides his heavy routine duties, he was able to do within a short period. At the time of his death he was engaged in preparing a *Bulletin* on Indian freshwater fishes for the Malaria Survey of India, a task of considerable responsibility.

Dev Dev Mukerji was a man of great personal charm and broad sympathies. He was liked by his superiors and colleagues, and in him the Zoological Survey has lost a very able and thoroughly reliable assistant. The science of Zoology, especially ichthyology, has become much poorer to-day by his premature death.

SUNDER LAL HORA.

CENTENARIES

S. R. Ranganathan, M.A., L.T., F.L.A.
University Librarian, Madras

Gellibrand, Henry (1597–1637)

HENRY GELLIBRAND, a seventeenth century mathematician of England, was born in the parish of St. Botolph, Aldersgate, London, on November 17, 1597. His father, Henry Gellibrand, M.A., was a Fellow of All Souls' College, Oxford, and died before the son entered the University. Gellibrand became a commoner of Trinity College, Oxford, in 1615 and took the M.A. Degree in 1623. Thereafter, he took holy orders and entered upon church work.

Change of Career

In the meantime, Sir Henry Savile had founded in 1619 two professorships at Oxford—the Savilian Professorship of Geometry and the Savilian Professorship of Astronomy. Savile himself held the Professorship of Astronomy for some time. While hearing one of Savile's lectures, Gellibrand was so impressed with it and his interest in mathematics was so roused that he gave up his curacy and decided to devote himself entirely to mathematics. He settled at Oxford and became a friend of Henry Briggs, of logarithms fame, who was then Savilian Professor of Astronomy. On the recommendation of Briggs, who was Professor of Geometry at Gresham College, London, till his arrival at Oxford, Gellibrand was appointed Professor of Astronomy at Gresham College in 1627.

His Publications

Gellibrand wrote several works. The chief of them are :—

(1) A discourse mathematicall of the variation of the magnetical needle together with its admirable diminution lately discovered.
(2) An institution trigonometricall.
(3) An epitome of navigation.

Trigonometria Britannica

But the most outstanding fame of Gellibrand as a mathematical author rests on the monumental publication entitled *Trigonometria Britannica*, which came out in two folio volumes in 1633. This was really a book left unfinished by his friend Briggs, when he died in 1630. In 1632, Gellibrand completed the book, adding a second part, all his own. A copy of this is available in the Royal Observatory. Gellibrand dedicated it to the electors to the Savilian Chair. From the preface, it is seen that Vlacq, another great enthusiast of the then newly discovered logarithms, took upon himself the cost of printing the work. It gives a table of sines for intervals of $0^\circ{\cdot}625$ to 19 places of decimals and of log sines to 14 places. The work divides the quadrant into 90° but divides each degree into 100 equal parts. An English translation of Gellibrand's part of this book was published in 1658 as part two of his *Trigonometria Britannica or the doctrine of triangles* by John Newton. A copy of this also is available in the Royal Observatory.

Gellibrand died of fever at London on 16th February 1637.

Turner, Edward (1798–1837)

EDWARD TURNER, the British chemist, was born in Jamaica in July 1798. He studied medicine at Edinburgh and graduated M.D. in 1819. Thereafter, he went to Gottingen and studied chemistry for two years under the celebrated analytical chemist Stromeyer. He returned to Edinburgh in 1824 and became a lecturer in chemistry. In 1828, when the University of London was founded, he obtained the Professorship of Chemistry in the University College and continued to hold it till the end of his life.

His Publications

In his short career, he published forty papers, most of which appeared in the *Edinburgh journal of science*. The readers of *Current Science* may be particularly interested in a paper of his published in Vol. 9 of that journal in 1828 under the title *Analysis of the solid contents of two hot mineral springs in India*. In 1825, he brought out a short but clearly expressed *Introduction to the study of the laws of chemical combination and the atomic theory*. His *Elements of chemistry* which first came out in 1827 and went through eight editions was remarkable for the comprehensive and lucid manner in which the whole science of chemistry was expounded. He

also contributed the mineralogical articles of the *Penny cyclopædia* published for the Society for the Propagation of Useful Knowledge.

His Contributions

His chief interest was in inorganic chemistry. He employed himself especially in perfecting the atomic theory. It was through his labours that the equivalent numbers of many of the elements were established. He was elected F.R.S. in 1831.

His End

In early life he was subject to disease of the lungs. In 1835, he was compelled by the declining state of his health to suspend all original researches. In January 1837, he was seized with inflammation of the lungs and died at his residence at Hamstead on February 13, 1837, to the deep regret of every friend of the progress of chemistry. He is said to have been a person of most engaging manners and appearance and of most amicable character, and his body was followed to the grave, with every manifestation of respect and affectionate attachment by the whole body of the pupils and professors of the University College, London. A marble bust of him was placed in the library of the College, the cost being defrayed by subscriptions from his pupils.

Mascart, Eleuthere Elie Nicolas (1837–1908)

MASCART, the French physicist and meteorologist, was born at Quarouble on 20th February 1837. He had his education at Ecole normale superieure. He became a Doctor of Science in 1864. Having been successively Conservator of the Collections in the Ecole normale, Professor of Physics in the Lyce de Versailles and the College Chaptal and having acted on several occasions as a Deputy to Professor Regnault at the College de France, he succeeded to the chair of Regnault in 1872. Later, in 1878, he became the Director of the Central Bureau of Meteorology in Paris. This post he held till his retirement in 1907.

Contributions to Spectroscopy

He was a prolific writer. He has to his credit more than 120 papers. His first few papers were on spectroscopy, the very first entitled, *Determination de la longueur d o'nde de la race A*, having appeared in *Comptes rendus* in 1863. He was one of the first to apply photography to the study of spectra. He devised a novel optometer and studied the distribution of colour sensation over the retina of the eye. Between 1874 and 1878, he made elaborate studies in the refraction and dispersion of gases. He investigated Doppler's theory and reached the conclusion that optical phenomena give no indication of the absolute motion of a body but only of its relative motion. This result earned for him the Grand Prix de Sciences Mathematiques in 1874. The culmination of his contribution to optics is his elegant *Traite d'optique* published in four volumes, in 1890–93.

Contributions to Electricity

Next, Mascart turned his attention to electricity and magnetism. Through his *Traite d'electricite statique 2 V.* published in 1876, he introduced Green's theory of potentials to the students of physics in Europe. He took a leading part in the determination of electrical units. The Electrical Exhibition and the International Electric Congress of 1881 brought him to the forefront in the debates on electrical units. His determination of the electrochemical equivalent of silver was accepted as the standard.

Contributions to Meteorology

As the Director of the Central Bureau of Meteorology in Paris for nearly thirty years, he succeeded in the face of numerous difficulties in gradually perfecting the equipment and organisation of the Bureau and in establishing the systematic publication in France of weather charts and weather forecasts. He published several *Bulletins* and *Observations* as the director. He early made his mark in the scientific study of meteorology. His observations in 1875 contributed largely to the conclusion that in the development of fogs and clouds, the presence of dust was essential.

His Honours

In 1884, he was elected to the Academie des Sciences, of which he became President in 1904. He assisted the Government in various committees and bureaus and in recognition of his public services, he was created Grand Officer of the Legion of Honour. He was the President of the Electrical Congress of 1900. He was also an honorary member of several foreign learned bodies and was the President of the International Meteorological Committee from 1896 to 1907.

He died at Poissy on August 26, 1908.

INDUSTRIAL OUTLOOK.

The Hydrogenation of Coal.

By Kenneth Gordon.

(*Imperial Chemical Industries, Limited, London.*)

The Chemistry of Hydrogenation.

During the last twenty years a feature of chemical industry has been the large-scale development of a new and powerful tool in the shape of high pressure hydrogenation. The first application was the synthesis of ammonia from nitrogen. This was followed by the conversion of carbon monoxide to methanol. The latest development of the process is the liquefaction of coal to form petrol, or indeed almost any oil product.

The hydrogenation of coal is, in fact, a destructive hydrogenation process, in which hydrogen is made to react with the coal at a temperature sufficiently high to break down the large and complicated molecules of the coal substance. The essential parts of the reaction are that coal is subjected to the action of heat and of high pressure hydrogen in the presence of catalysts.

The main function of the high temperature is to effect the well-known cracking reaction which simplifies the molecular structure of the coal and produces molecules of the size required.

The main function of the high pressure hydrogen is to increase the yield of the desired product by preventing coke formation. When coal is heated in the absence of hydrogen, the large coal molecules, which contain relatively little hydrogen, are broken down into smaller molecules, some of which are richer in hydrogen than the original coal molecules, and some are poorer. Those that are richer form the yield of light oil and petrol, together with a certain amount of gas containing still more hydrogen, the formation of which may not be desired but always takes place to some extent. The molecules that are poorer in hydrogen, being highly unsaturated, polymerise rapidly to form coke and heavy oils. On simple application of heat, therefore, it is clear that the yield of a desired light oil product of relatively high hydrogen content is limited by the hydrogen content of the coal treated. When bituminous coal is heated, for example, about 80 per cent. of the pure coal substance is converted to coke.

When the heating of the coal is carried out in the presence of high pressure hydrogen, however, coke formation can be avoided, since unsaturated molecules react with hydrogen so that polymerisation is prevented and the yield of light oil products is increased enormously.

A further effect of the hydrogen is to remove the undesired oxygen, nitrogen and sulphur which are present in coal in chemical combination with carbon and hydrogen. These are converted by the hydrogen into water, ammonia and sulphuretted hydrogen, which are subsequently separated in the form of an aqueous solution. (Fig. 1.)

The function of the catalysts is to accelerate the desired reactions. Various catalysts are used in practice, all of which favour, in general, both the cracking reaction and the addition of hydrogen, but to different relative extents. The choice of catalyst depends on the nature of the raw material and of the desired product.

Hydrogenation may be effected either in the liquid phase or in the vapour phase.

Liquid phase reaction is employed when hydrogenating coals or heavy oils. In treating coal, for example, it is first finely ground and mixed with heavy oil, and the mixture is heated and introduced together with hydrogen into a reaction vessel, the suspension of the coal in oil being kept agitated by the stream of hydrogen bubbling through it. Catalysts are introduced in the form of powder either mixed with the original coal or injected separately as a suspension in oil.

Vapour phase reaction is used in the treatment of lighter oils which, in the presence of hydrogen, are completely vaporised at the reaction temperature. In this case the heated oil vapour is passed, together with hydrogen, over solid catalyst in the reaction vessel.

It is by altering the conditions of the reaction that such varied feed materials may be treated by hydrogenation to give varied

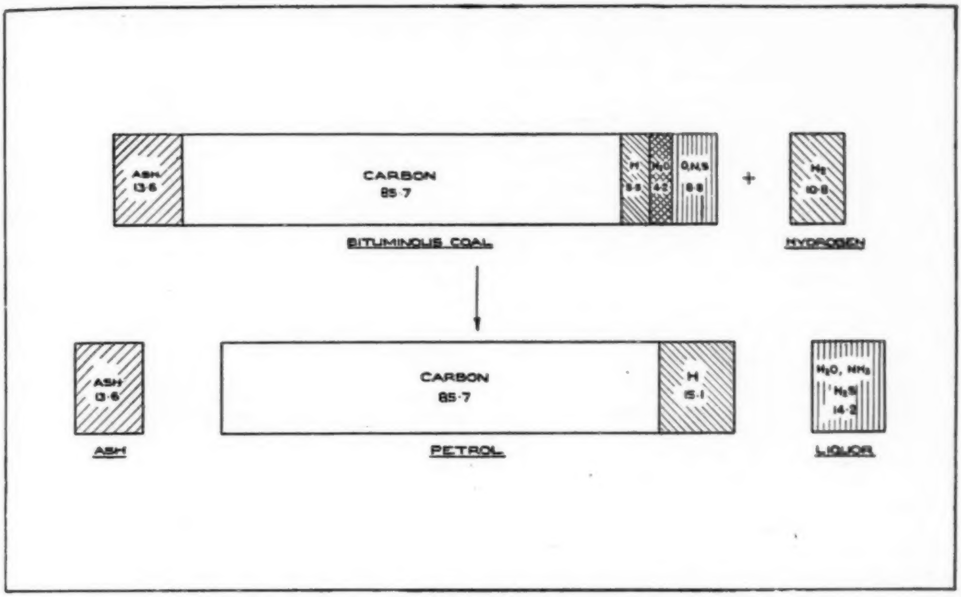


Fig. 1.
The Conversion of Coal to Petrol by Hydrogenation.

products. In general, lower temperatures tend to give more saturated products containing more hydrogen than those obtained at high temperatures, since the latter favour the cracking reaction at the expense of saturation with hydrogen.

Thus, by working in the liquid phase at a low temperature of about 400° C., heavy oils can be hydrogenated without much cracking, and in this way, for example, lubricating oils can be improved in quality.

In the vapour phase, similarly, by working at low temperatures crude petrol can be refined without much cracking and middle oils can be gently hydrogenated to form kerosene. By working with high temperatures of above 500° C. and with suitable catalysts, petrols with exceptionally high anti-knock properties can be produced.

However carefully the reaction conditions for any particular hydrogenation reaction are chosen, it is impossible to avoid the production of a certain quantity of gas during the cracking reaction, particularly at high temperatures. Although gas formation does not altogether represent a loss of efficiency in that the gas, consisting largely of methane and ethane, can be reacted with steam to give the major part of the hydrogen requirements of the plant, it does, nevertheless, represent a loss of oil output which must always be considered when choosing the most suitable conditions of catalysis and temperature for any particular hydrogenation reaction.

In producing petrol from coal it is possible to obtain a yield of petrol by direct liquid phase hydrogenation. It has however been found to be greatly preferable to work with a two-stage process, the liquid phase reaction being followed by a secondary vapour phase reaction in which middle oil formed in the first stage is hydrogenated to petrol. In some circumstances it is economic to introduce an intermediate stage to convert heavy oil formed in the original coal hydrogenation stage into middle oil.

Principles of a Large-scale Coal Hydrogenation Plant.

It is generally economic to remove a portion of the ash in the coal before introducing it to the high pressure hydrogenation plant. This may be effected by any one of numerous well-known processes, for example,

air elutriation followed by flotation on well-agitated sand and water mixtures. In working with brown coal it is advisable to remove the water content by drying.

The coal is finely ground and mixed with an equal weight of circulating heavy oil returned from a later stage in the process. This results in the formation of a coal paste, which is a suspension of coal in oil and which, at the temperature employed, is fluid and can be readily handled in pipe lines and pumps. The paste is fed to hydraulically operated pumps which deliver it at a pressure of 250 atmospheres through high pressure pipes to the reaction unit.

The reaction unit consists of interchangers, preheater, reaction vessels known as converters, cooler and catchpots or separators (Fig. 2). The coal paste is joined by a stream of high pressure hydrogen, after which the combined mixture is heated to reaction temperature (400–500° C.) by passing through the interchangers and preheaters. In the interchangers, which are in general, of the tube-stack type, the cold feed is partially heated by heat exchange with the hot products leaving the converters. In the preheater it passes through tubes which are heated by the hot gases from a fuel gas burner.

The heated mixture then passes to the converters, of which there are generally two or more, arranged in series.

The converters consist of large forgings (height 45 feet, diameter 6 feet, for example), enclosing reaction vessels, the combined volume of the latter being sufficient to give the required time of reaction. The internal reaction vessel is separated from the external forging by insulation. Consequently the internal vessel withstands the reaction temperature but no pressure, and the external forging withstands the 250 atmospheres pressure but not a high temperature. This design obviates the use of special steels for the heavy forgings.

The hydrogenation reaction which takes place in the converters is highly exothermic, and these vessels are consequently fitted with thermocouples for the measurement of temperature, and suitable means for control.

The catalysts required for the reaction are either added in the form of powder to the original coal paste or injected separately

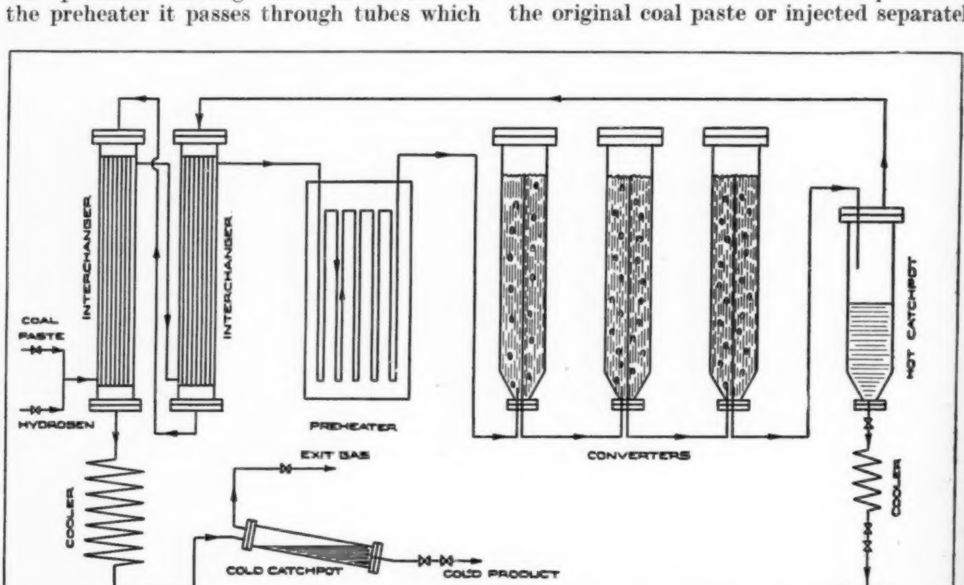


Fig. 2.
Diagram of Full Scale Hydrogenation Unit.

at some point in the system in the form of a suspension in oil.

On leaving the converters the products pass immediately to the hot catchpot. This is a separator which is maintained only a few degrees lower than the reaction temperature, and in which separation is made between the vaporized and non-vaporized products of the reaction. The non-vaporized product is a sludge which contains the ash content of the original coal, unconverted coal and heavy oil. This sludge is cooled, released from pressure and treated by centrifuging and a special carbonisation process to recover its oil content and give a small purge from the reaction system of ash introduced with the coal feed and of unconverted coal. The purge is obtained in the form of a low grade coke which is employed as a boiler fuel. The oil recovered from the sludge is recirculated to form part of the oil used for pasting the coal feed. Any sludge which is not subjected to this oil recovery process is recirculated directly and used for making coal paste.

The main products from the reaction leave the hot catchpot in the form of vapour and pass through the interchangers and cooler, after which, at atmospheric temperature, they enter the cold catchpot where there is a further separation between liquid and vapour or gas.

The gas fraction from the cold catchpot consists mainly of hydrogen accompanied by hydrocarbon gases formed by the undesired extreme splitting reaction in the converters. The hydrocarbons are largely removed by passing the gas together with high pressure oil through a wash tower, and the purified hydrogen then passes to compressors where it is boosted to its original pressure and recycled to the reaction unit.

The liquid fraction from the cold catchpot is the main product from the reaction. It is released from pressure and passed to storage tanks where it is allowed to stand for several hours to separate an aqueous layer containing water, ammonia and sulphuretted hydrogen formed from the oxygen, nitrogen and sulphur in the original coal.

The oil product is then pumped to a distillation plant where it is fractionated into a heavy oil, a middle oil and a petrol.

The middle oil fraction is further hydrogenated to form petrol in a vapour phase reaction unit (containing interchangers, preheater, converters, cooler and catchpot), similar to the reaction unit used for the hydrogenation of the coal paste, but differing from it in that the converters contain solid catalysts suitably supported and there is no hot catchpot since the entire product is vaporized at the reaction temperature. The oil product from this reaction unit is finally fractionated in the distillation unit to give petrol of the desired volatility and a middle oil fraction which is returned to the reaction.

The heavy oil fraction from the distillation of the product from the coal hydrogenation unit is recirculated and used for pasting the coal feed.

In some circumstances it is found economic to operate the coal reaction unit to produce more heavy oil than is required for mixing with the coal feed. The excess heavy oil is then hydrogenated in a secondary liquid phase reaction unit similar to the first. The oil product is fractionated at the distillation plant to give heavy oil, middle oil and petrol fractions. The heavy oil is recirculated to the liquid phase reaction, and the middle oil passes to the vapour phase reaction.

A diagrammatic flowsheet of the bituminous coal hydrogenation plant at Billingham, which includes a secondary liquid phase reaction unit, is shown in Fig. 3.

The major part of the petrol output of the plant is obtained from the product of the vapour phase reaction unit. It is immediately washed with caustic soda to remove sulphuretted hydrogen, but requires no further refining treatment. Petrol from the liquid phase reaction units is refined by washing with caustic soda and sulphuric acid, followed by redistillation.

Hydrocarbon gas, formed by the undesired extreme cracking reaction in the converters, is formed as a by-product. The gas is evolved when pressure is released from the wash-oil used to purify the hydrogen leaving the reaction units, and from the main oil products from the reaction units. The richest part of it contains a petrol fraction which is removed in an absorber and stripper at the distillation unit. Butane or propane may also be removed from it and sold in

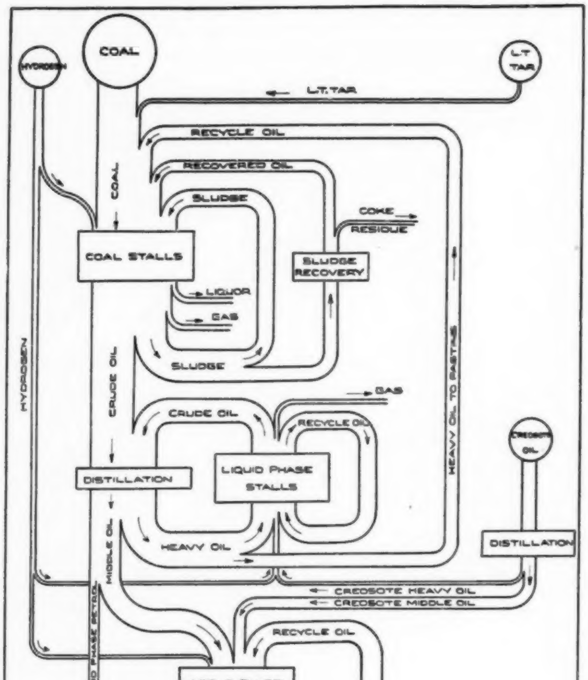


Fig. 3.

Flow Diagram of Billingham Plant for Hydrogenation of Coal, Creosote Oil and L.T. Tar.

cylinders for use as fuel gas. The remainder of the by-product gas may be used as a fuel gas on the plant, but is most useful for the manufacture of hydrogen by treating it with steam in the presence of catalysts, a process which was originally worked out by the I.G. and Standard Oil Company (New Jersey). In this way it is possible to provide the major part of the hydrogen requirements of a coal hydrogenation plant.

Further by-products which may be isolated separately or may, if desired, be further hydrogenated to form petrol, are phenol, cresol and high homologues.

History of Hydrogenation.

The original conception of producing oil and petrol from coal by hydrogenation is due to Bergius. Commencing shortly before the War he carried out numerous experiments in externally heated autoclaves. These eventually culminated in a small continuously operated plant at Rheinau, near Mannheim, which was operated until 1927.

The I.G. commenced experimental work on the subject after the War. They made two great advances; the discovery of catalysts immune to poisoning by sulphur, and the division of the reaction into liquid phase and vapour phase stages. In consequence they were able, in 1927, to build a large-scale plant at Leuna designed to produce 100,000 tons per year of petrol from brown coal. For the first few years the plant operated mainly on low temperature tar from brown coal and German crude petroleum. Since 1931, however, direct hydrogenation of brown coal has been the main source of output, and in the last year or two extensions have been made to the plant until at the present time the output is 325,000 tons per year of petrol.

In 1927, the I.G. entered into an agreement with the Standard Oil Company (New Jersey), and the latter then built two hydrogenation plants in America, which have been used for the production of petrol, special solvents, lubricating oils and kerosene.

I.C.I. commenced work in 1927, concentrating mainly on the production of petrol from bituminous coal, being the most suitable application of the hydrogenation process for conditions in England. They operated a large-scale experiment from 1929 to 1931 in a plant treating 10 tons per day of bituminous coal.

In 1931 the four major operators in the

field—namely, the I.G. of Germany, The Standard Oil Company (New Jersey), the Royal-Dutch Shell Group, and the I.C.I.,—associated themselves in a pooling company, the International Hydrogenation Patents Co., in order to pool their patent rights and to effect a general exchange of technical information, the I.C.I.'s interests being centred in the British Empire. At the same time arrangements were made for marketing products through existing oil-distributing Companies.

This pooling of technical resources on an altogether unprecedented scale has been uniformly beneficial, and the I.H.P. group is now pre-eminent technically and their patent position very strong. Even apart from the patent position it would seem imprudent to attempt to operate independently when there are available such great accumulated practical experience and technical resources as are possessed by the constituent Companies in the I.H.P. pool.

In 1935, I.C.I. started a large-scale plant at Billingham-on-Tees to produce 100,000 tons per year of petrol from bituminous coal and 50,000 tons per year of petrol from bituminous coal tars, the total output of petrol being 150,000 tons per year.

In 1934 while the above plant was being erected, the I.G. carried out a large-scale experiment on the hydrogenation of bituminous coal, which operated successfully for four months. A large-scale plant is starting this year (1936) at the Hibernia Colliery in the Ruhr, to produce 125,000 tons per year of petrol by the hydrogenation of bituminous coal. In addition, the Braunkohle-Benzin A.G. (Brabag) is now building two plants, one of which is now commencing operation, in which petrol is to be produced by the hydrogenation of low temperature tar obtained from brown coal.

Large-scale plants operating or about to operate the I.H.P. destructive hydrogenation process are detailed in the following table :—

Firm	Place	Country	Raw Material	Date of Starting	Rated Annual Output Tons
I.G.	Leuna	Germany	Brown coal Brown coal tar Creosote oil German petroleum oil	1927	350,000
S.O.Co.	Baton Rouge	U.S.A.	Petroleum oil	1930	250,000
"	Bayway	U.S.A.	"	1930	250,000
I.C.I.	Billingham	Great Britain	Bituminous coal Creosote oil L. T. tar	1935	150,000
Brabag	(Two Plants)	Germany	Brown coal tar	1936	300,000
Hibernia	Scholven	"	Bituminous coal	1936	125,000
A.N.I.C.	Bari and Livorno	Italy	Petroleum oil	under construction	200,000

The combined capacity of the above plants is 1,625,000 tons/year of petrol.

Products of Hydrogenation.

The flexibility of the hydrogenation-process is evident not only in the diverse natures of the various raw materials which can be used, but also in the varied types of products which can be obtained.

When the process is operated to produce petrol, for example, the knock rating and volatility of the petrol may be varied as desired within wide limits. The following table gives the more important properties of three types of petrol produced by the hydrogenation of bituminous coal.

" 1 " refers to a petrol obtained directly from coal stage reaction, and corresponds to the specification of a typical No. 1 spirit in England.

"2" indicates a vapour phase petrol made up to a typical Ethyl Spirit specification with lead.

"3" is a leaded aviation spirit.

Properties of Petrol from Bituminous Coal Hydrogenation.

	1	2	3
Specific gravity	0·740–0·745	0·734–0·738	0·730
I.B.P.	35 deg. C.	35 deg. C.	35 deg C.
90 % vol. recovered at	158 ,, ,,	160 ,, ,,	150 ,, ,,
F.B.P.	170 ,, ,,	170 ,, ,,	165 ,, ,,
Residue	1·0 %	1·0 %	1·0%
Loss	1·0 %	1·0 %	1·0%
% Distillation + Loss at			
70 deg. C.	20 %	19%	21 %
100 ,, ,, ...	40 %	40 %	50 %
140 ,, ,, ...	75 %	75 %	87%
Reid Vap. Pressure at 100 deg. F.	9 lb.	9 lb.	7 lb.
Octane No. C. F. R. Motor Method	71–73	80	..
Octane No. C. F. R. Aviation Method	..	..	87
Colour	+ 25 Saybolt	Red	Blue
Odour	Marketable	Marketable	Marketable
Sulphur, % by weight	0·5	0·01–0·02	0·01–0·02
Doctor Test	Negative	Negative	Negative
A.S.T.M. Copper strip corrosion test	,,	,,	,,
Gum, pyrex dish without air jet (mgm./100ml.) ..	2·0	Up to 3·0	Up to 3·0

Large-scale coal hydrogenation plants have so far been operated mainly to produce petrol as the main product. The process can, however, be altered to produce almost any other type of oil product. Thus the heavy oil obtained from coal forms an excellent fuel oil without further treatment. Diesel oil may be obtained by direct hydrogenation of brown coal, or by mild hydrogenation in the vapour phase of middle oil obtained by hydrogenation of bituminous coal.

Up to the present time very little work has been done on the production of lubricating oil from bituminous coal, but it is known that heavy oil made by the hydrogenation of brown coal may be converted into lubricating oil by further hydrogenation over a static catalyst. This process of hydrogenation with a static catalyst is used by the Standard Oil Company of New Jersey for the large-scale production from high boiling petroleum fractions of best quality lubricating oil rich in hydrogen and with a flat temperature-viscosity curve.

Loss of yield caused by extreme cracking reactions which form coke and gas are minimised, as mentioned before, by the high pressure hydrogen and comparatively low temperatures. Consequently yields are high. For example, the yield of petrol from bituminous coal calculated on an ash and moisture free basis is more than 60 per cent. by weight. The yield of petrol from tars and oils is 80–90 per cent. by weight.

The most important figure is the over-all coal consumption, including coal used for producing all the hydrogen and services necessary such as electric power and steam. For producing petrol from bituminous coal the over-all requirement per ton of petrol is 3·5 to 4 tons of raw coal, the exact figure depending on the ash and moisture content of the coal and its suitability for the process. Thus, the thermal efficiency is 40 per cent., which may be compared with the figure of 25 per cent. for generation of electric power.

The Insecticidal Properties of Kerosene and Lubricating Oil-Emulsions.

By U. S. Sharga.
(*Agricultural College, Cawnpore.*)

LIGHT oils having insecticidal properties have been known since 1897. The ignorance of the physical and chemical properties of the emulsions, and the want of standardization, have lately brought them into disrepute. Recently in Europe and America, a fresh impetus has been given to the use of heavy oils, specially lubricating oils and this is fast taking the place of lime-sulphur wash in dormant sprays for scale-insect control.

A few laboratory and field observations were therefore made with kerosene and lubricating oil-emulsions and the nature of their actions on a large number of insects including scale-insects was noted. Only a few oil-emulsions are effective against scale-insects. The insecticidal properties of oil-emulsions are dependent on the following factors:—(1) The manner in which the oil is mixed. (2) Kind and quantity of soap used. (3) Type of oil. (4) Composition of the water employed, and (5) Temperature of the emulsions used for spraying. All factors being similar, oils with 80–100 viscosity (resistance to flow, "Saybold test") are quicker to emulsify than those between 30–40 viscosity. The size of the globules in the emulsions determines their insecticidal property.

Stability.—Different sizes of emulsified oil globules have different properties, as is indicated by the work of Moore[1], Richardson,[2] Griffen and Burdette and English.[3] The less stable the emulsion, the greater is the amount of oil thrown to the surface of the spray-drops. In killing aphids the most effective emulsions are those which are relatively unstable and are good wetters. On the other hand, those emulsions which have a high wetting ability are injurious to foliage. Kerosene emulsion is a good wetter. The size of the emulsified oil globules are small and it effects a high kill of aphids. But it also burns the tender foliage if it is not made in the proper manner and proportion.

Viscosity and volatility.—The results obtained by De Ong[4] and English[3] in spraying against citrus scale and oyster shell scale may be taken as a fair indication of the effectiveness of oil emulsions against other scale-insects also. A spray of 60 viscosity and 5·3 per cent. volatility is not so effective as sprays of slightly higher viscosity and lower volatility. Kerosene oil of 32 viscosity and 35·1 per cent. volatility emulsified in sodium or potassium soap is ineffective (English[3]). For scale-insect control the oil should not, normally, be below 80 viscosity and should not have a volatility of over 1 per cent.

Wetting and spreading.—A good wetter is a good killer of insects owing to the physical and chemical reactions that it can produce on or inside the insect body. The spreading of the emulsified substance on insects is followed by killing. Aphids are not readily killed by sprays that do not wet them and wetting is secured by the addition of soap. Oil emulsified in tap water is not so stable as in distilled water and stability is one factor upon which depends the killing action of the oil emulsified.

Saturated and unsaturated oils.—The killing power depends upon the type of oil and the amount of emulsifying agent employed. The unsaturated oils may be more effective than saturated oils if the emulsion is of the unstable type. In controlling scale-insects, the action of an oil-emulsion is largely a physical one, that of suffocation. If death is due to penetration, the oils of low viscosity should be more effective, but high volatility is usually associated with low viscosity and if death is to be effected by penetration alone, the oils should persist for some time. The ineffectiveness of light oils has also been demonstrated by Moore[6] and Graham; these oils evaporate too quickly to cause penetration and death. According to De Ong,[4] scale-insects actually expel the light oils from their tracheal system. It is therefore better to use an emulsion that will release quickly an oil of sufficiently high viscosity and low volatility to give a residue that will persist for some time to cause death by suffocation. This is well supported by the observations made by the author on the lubricating oil-emulsions, *Castrol A.A.*

Kerosene oil emulsion.—This emulsion was prepared with 1 oz. of sodium soap (Bar Soap), 10 oz. of water and 20 oz. of kerosene oil. Stock solutions were briskly agitated for 30 minutes and a sample was examined under the microscope. Oil globules of all sizes were found and there were numerous globules of small sizes contiguous with each other. When diluted six times (Temp. 30° C.) the oil globules were found scattered. Substituting soft soap for hard soap and keeping the same proportions, the emulsification was better and the globules were much more even in size and very closely packed; with dilution, they were scattered but still closely packed. The difference in the compactness of globules and their sizes is well marked in the two types of emulsions prepared with hard soap and soft soap. Light oils and soaps of known analytical characters should be employed for preparing the emulsions in order to obtain definite results. The size of oil globules formed is an important factor in the killing of aphids, jassids, etc. The small globules formed run well over the insect body dissolving the waxy coating if any and the death of the insect is almost instantaneous.

Lubricating oil emulsion.—*Wakefield Castrol AA* was used in preparing this emulsion. It is a medium-heavy oil with a B.P. over 240° C. The emulsion of this oil was prepared in the same way and with the same proportion of soap and water as with kerosene. Examination of the emulsion was made under the microscope. In this case the oil globules were of very large size, small globules were also present. When soft soap was used the emulsion was better; globules were contiguous and the size of the oil globules was small. On dilution the globules were scattered but their size was maintained. The volatility was remarkably low and the droplets showed a tendency to run together in a short time. With a fall of temperature an oil residue was invariably left and this is a highly desirable quality in scale-insect control. It can

be effectively used on various species of *Aspidiotus, Pulvinaria, Icerya, Lecaneum* and other coccids. In the control of these scale-insects, wetting power is not so much needed as the large size of the globules found in *Castrol AA*. Several of the large size globules completely cover up the scale, causing death through suffocation. Besides, the emulsion from lubricating oil is not penetrating and not so dangerous to foliage as the kerosene oil emulsion. Lubricating oil is also not likely to cause canker of stems, branches and twigs and the future prospects of its use as sprays against scale-insects in India appear to be great. Detailed results on these will be published elsewhere.

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[1] Moore, *Univ. Minn. Tech. Bull.*, 1921, **2**.
[2] Richardson, Griffen and Burdette, *Jour. Agric. Res.*, 1927, **34**.
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[4] De Ong, *Jour. Eco., Ent.*, 1926, **19**.
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[6] Moore and Graham, *Jour. Agric. Res.*, 1918, **13**.

Biochemistry in Relation to Agriculture.

By Sir John Russell, D.Sc., F.R.S.

"YOU, at the Indian Institute of Science, are engaged in a field which offers great opportunities to add to the richness of life, to alleviate human sufferings and to improve the lot of the millions of agriculturists in India; and I hope that the triumphs and achievements of biochemistry will further be improved by the work that you are doing at the Institute"—so declared Sir John Russell, Director of the Rothamsted Experimental Station, in concluding an interesting address on "Biochemistry in Relation to Agriculture" which he delivered under the auspices of the *Society of Biological Chemists* at Bangalore on December 15th, last.

Biochemistry, said Sir John, was the chemistry of substances concerned with life. In the early days of biochemistry that subject had been a distinct branch of chemistry and people had thought of life as entirely distinct from non-living things. That was the origin of the distinction between organic and inorganic chemistry, a distinction which still survived and caused confusion among students. In the second period of the study of biochemistry it was shown that substances with life could also be synthesised in the laboratories and that there was no fundamental difference between organic and inorganic substances.

Later still the difference became one purely of convenience in study. In reality the realm of nature was one and indivisible but they classified their studies into different groups because one could not study every field.

Agriculture.—Referring to agriculture, Sir John said, that one Professor had defined it "as something to keep away from". In his young days, he had been warned that there was no career to be made out of agriculture. He, however, held that there was a great deal in agriculture and that there was a close connection between agriculture and biochemistry. As a result of recent studies in biochemistry they had found it possible to define quality in relation to crops. In England, for example, quality problems in connection with crops were first studied in relation to barley which was used in the production of beer. Later, the studies in quality extended to wheat and it was found that there were three different kinds of wheat—one which was best adapted for loaves, another which was good for biscuits, and another which was good for macaroni. What was good for one purpose was not necessarily good for the other two. Biochemical study had been able to relate the composition of wheat in a general way with the question of its suitability to any purpose, but the details were still obscure.

In India they had a particularly important set of problems concerned with the food of the people, especially of the Indian ryot, who as they all knew, was the basic foundation on which the whole of this country was built. In order to arrive at the normal daily food available for consumption by the average ryot, Sir John had collected figures referring to the total crop production in India and found that the average consumption of grain by the Indian ryot worked out at about one pound per head per day. In the Punjab and in Bengal it was slightly over a pound, while it was slightly under a pound in Madras. Curiously enough, these figures tallied closely with those for consumption furnished by the ryots themselves whom Sir John had interrogated. The normal food of the ryot in the Punjab consisted of fifty per cent. wheat, thirty per cent. gram and the rest of cereals. That would furnish a diet very rich in protein. In Bengal the diet was very poor in protein, as it was almost wholly composed of rice. In Madras they had an intermediate sort of diet, rice accounting for 70 per cent. and the rest being made up of protein foods.

Protein Content of Grain.—There is great need for the determination of the nature and amount of proteins present in the common grains in use in India. They knew the protein contents of wheat and barley but they wanted more information than was available now, about the proteins of Indian grains. Till that study was completed they could not say how the daily diet of the Indian ryot could be improved. Agriculturists could not be expected to know what foods to grow from a dietary point of view.

What was the source of vitamins for the Indian ryot and agriculturist? In an Indian village, he had met an old man who could not say how old he was, but was obviously above 70 years. If one could accept his own account of his diet, he would have had very little of the vitamins A, B, C, or D. That would constitute a biochemical mystery making one wonder whether by some physiological process the Indian ryot had evolved the secret of protecting himself, against deficiencies of vitamins in his food. Scientists, perhaps, in an effort to explain it away, would fall back upon the abundance of brilliant sunshine

which they had in India. Sir John felt that there was a great deal in it and that the abundant sunshine might somehow or other make it unnecessary for the Indian ryot to have as much vitamin supply as was needed in less sunny countries.

That did not, however, mean that there was no room for improving the diet of the Indian ryot. That could and should be improved. That problem could be solved only after they had solved the biochemical problems relating to Indian food products.

Livestock Problems.—Sir John then referred to the conditions of animal stock in India and said that everywhere in India, poor stalks of grain crops, and poor grazing fields provided the main food for cattle. That was an inadequate diet for animals. There was a great need to radically improve the dietary of animals both in quality and in quantity. He was glad to note that at the Animal Husbandry Conference held in Madras, they had on the previous day (December 14) emphasised that point. The bullock was the greatest source of power for agriculturists in India and they had to remember that power could not be produced out of nothing. The problem of milk supply was also one which required their immediate attention. In most villages milk could be got only in very small quantities by the children and sometimes not at all.

Nitrogen Fixation in Soils.—Referring to the need for a scientific study of soils, Sir John said that they had not yet fully understood the remarkable cycle in Nature with reference to nitrogen production. Though that subject had been fairly fully studied in connection with the temperate climates, yet in the tropics it still remained to be studied adequately. Particularly, with reference to soil study, they had to conduct large-scale field experiments to ascertain facts and to work out processes. Some work in that direction had been done in U. S. A. But the results obtained there did not agree with those obtained in temperate climates, such as in England. In England they had established that the source of nitrogen in the soil was leguminous plants. But in the arid regions of U. S. A., they failed to get clear evidence of fixation by leguminous plants. What they should know was whether or not, in a country like India, fixation by free living organisms played an important part as a source of nitrogen. That was a problem of fundamental importance in soil study. In England they could not determine whether nitrogen fixation proceeded independently of leguminous plants. That could only be done in a tropical climate. Even in regard to experiments connected with composts and farm manures they found that the results varied as between England and America. Therefore if they wanted to obtain satisfactory solutions for their problems connected with agriculture, biochemists in India would have to solve them.

Water-logged Soils.—The chemistry of water-logged fields was another direction in which experimental work by biochemists would prove of great value to the Indian ryot. The conditions relating to water-logged areas in India differed very much from those in England, where water-logged areas were merely swamps where the water was stagnant. On the other hand, in India the water was being constantly renewed in water-logged areas owing to evaporation and replacement by fresh water. At present not enough was known about the micro-biological conditions of paddy soils. Sir John felt sure that there was great scope for the application of modern biochemical knowledge towards the improvement of paddy cultivation, especially by way of extension of the pioneering work carried out by Harrison and Iyer in that direction.

Utilisation of Wastes.—The use of waste products was another direction in which the biochemist could help a great deal. The possibilities of utilising on a commercial scale, plants and plant products which were not edible deserved study.

The biochemist could also contribute a great deal by studying problems connected with the utilisation of sewage. Sir John was glad to note that Dr. Gilbert Fowler, who had done a great deal of successful work in that direction, was present at the meeting. In the West as in England they had succeeded in disposing of the sewage in a healthy manner, though in a wasteful way. Dr. Fowler's method, however, enabled the Western method of sewage disposal to be adopted without losing the manurial value, especially in regard to nitrogen and phosphates. Phosphates formed an important fertilizer material whose supplies were almost monopolised by France and America. Thanks to the activated sludge method it had become possible to recover a considerable portion of the phosphates from sewage. The only problem in that connection which remained to be solved was that of drying the truculent colloids. The retention of moisture by colloids was a problem for the man of physics to solve.

Concluding, Sir John referred to the rapid growth of the sugar industry in India and the possibility of putting the by-product, *viz.*, molasses, to much better use than was being done now.

Physics in Hungary—Past and Present*—I.

By R. Ortvay, *Budapest.*

Introduction.

Hungary is a small country in a part of Europe where Western civilization meets East-European civilization developed under Byzantine influence and which was sometimes reached by the waves from the East. The Hungarians are an Eastern people, they came here from the East a thousand years ago, but their civilization is rather Western than East-European. In an unquiet part of Europe, at times defending itself and Europe against the East, at times fighting for its independence with the West, it has survived for 1,000 years and, suffering at present but not crushed, it is still hoping for a better future. Twice it was almost swept away from the earth. First, in the thirteenth century it was overrun by the Mongols and was almost ruined; then again in the sixteenth and seventeenth centuries, for 180 years, the greatest part of the country was occupied by the Turks. In the course of history Hungary had difficult fights with Austria to which it was joined by the person of the same ruler. Hardly had its relation with Austria improved, when the territory of the country was reduced to one-third of its former size after the Great War, and it was almost numbed in its national existence. But people believe with unaltered hope in the justice of Providence that things may change one day. It is quite natural that in such circumstances Hungary does not belong to the leading nations of European civilization and it does not occupy the place that the little nations in the West do in more favourable circumstances. Nevertheless Hungary always does her best to take part in any intellectual movement in Europe, contributing largely to the advance of European culture.

You have also had the opportunity to meet some representatives of Hungarian science; a scholar whose name is certainly familiar to many in India, A. Körösi-Csoma, was the first to compile a vocabulary of the Tibetan language; his tomb is still in Darjeeling.

You know the name of Sir Aurelius Stein, a Hungarian by birth who lives in India when not away on an expedition to fathom the secrets of Asiatic history.

I.

After this general introduction allow me to proceed to a discussion of certain moments of Hungarian physics of general import.

In the fifteenth century, in the reign of King Mathias Corvinus the fortress of Buda, now part of the capital city Budapest, was a splendid seat of Renaissance culture, the meeting place of foreign artists and scientists. Also the well-known astronomer John Regiomontanus had lived there for some years. But this promising beginning was soon swept away by the waves of the coming Turkish invasion. Later on in the reign of Queen Maria Theresa we find the Jesuit Max Hell one of the first to observe the solar transit of Venus. At the end of the eighteenth century and in the beginning of the nineteenth century lived the two Bolyais, father and son. It is well known that the younger of them John Bolyai was one of the first mathematicians, who independently of others invented a non-Euclidean geometry without any inner contradiction. I cannot go into details concerning the later development of Hungarian mathematics. I only wish to mention that John Segner, the inventor of the well-known rotating wheel, was also born in Hungary.

A pioneer of Hungarian physics, an interesting and original thinker was A. Jedlik, a Benedictine friar, Professor in the University of Budapest. He was the type of the unselfish, humble scientist who liked science for itself and did not want to bring it in connection with practical life. He made optical gratings with his self-made dividing machine, and constructed long before Siemens, an electric machine based on the dynamo principle. But Siemens perceived immediately the fundamental importance of this principle, on which an immense industry was built; Jedlik, on the other hand, never thought of a practical application and only cared for the working of his machines.

Now I shall pass on to a more modern and more powerful personality, Baron R. Eötvös, the most prominent representative of Hungarian physics. He came of a noble, historical family; his father was one of the most prominent and celebrated writers and politicians of the liberal era. He studied at German universities, was much influenced by Kirchhoff and was always more inclined towards phenomenalism than towards the corpuscular theory the popularity of which was rapidly growing in his time; he could appreciate, however, the final success of the latter.

Among his many-sided theoretical and experimental investigations in physics I shall only confine myself to his researches in gravity and capillarity.

A great part of his investigations in gravity is concerned with the change of the force of gravity on the surface of the earth and gives a method to determine this local variation which is the second derivative of the potential of gravity.

In other words his method makes it possible to determine the equipotential lines of gravity.

His method is based on a modification of the torsion-balance of Cavendish: a horizontal rod is suspended in the middle by an elastic wire and bears on both ends weights of equal masses. One of the two weights is joined closely to one end of the rod, the other hangs on a wire fixed at the other end. If the field of gravity is different in direction and intensity in the places of the two weights the equilibrium of the balance cannot result only from gravity, the balance will turn till the moment arising from the torsion of the wire makes a new equilibrium. The theory of the method shows that if we observe this elastic moment in six positions differing by angles of 60 degrees, we can obtain the six second derivatives of the potential. The idea of the method is very simple, but Eötvös had to overcome extraordinary difficulties in

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order to make his instrument function not only in his laboratory, but also in the open air. He was not only obliged to find out the quality of the elastic suspension wire, but he was obliged to eliminate some other disturbing circumstances, especially thermal air currents, arising from the unequal temperatures of the different parts of the instrument. He could not evacuate his instrument because the air was needed to damp the vibrations. Therefore he put the balance in a three-fold metal box and regulated the air current in such a way, that then the instrument met every demand. After perfecting his method Eötvös with the help of some prominent pupils measured large areas and determined the change of gravity and the connection between the anomalies of gravity and the geological structure. It is of very great practical consequence that the method of Eötvös makes it possible to determine the geological anticlinals and salt-domes which are often connected with oil. Such researches were made in Europe as well as in America and also in India by the order of the Burma Oil Company. Three expeditions were made in the winters of 1923-24, 1924-25, 1925-26 to Upper Indus, Upper Assam and in the State of Khairpur under the direction of D. Pekár, who as the Head of the Eötvös Geophysical Institute directed these researches with the help of many others after the death of R. Eötvös.

Another prominent pupil of Eötvös, S. Rybár, had put the Eötvös balance in a more handy shape and provided it with automatic photographic registering apparatus which saves much time and work. Because Eötvös did not apply for a patent for his instrument, other firms sell similar instruments; to-day they are indispensable for geophysical research.

Eötvös went with his balance into other questions of great theoretical importance. He investigated the question whether gravity is absorbed by matter. At sunrise or sunset there is a position for the balance in which the gravity of the sun is acting through the air upon the upper load, but through several miles of the earth upon the lower one. In spite of the sensibility of this method no absorption was to be observed.

The researches concerning the proportionality of the gravitational and inert masses are of greater importance. With the help of pendulums made of different materials, Newton proved that such proportionality existed within the limit of 1/1000. Later Bessel reduced this limit to 1/60,000 but nobody made such exact measurements as Eötvös and his pupils. Eötvös, Pekár and Fekete in their excellent work which won the first Beneke-prize of the University of Göttingen reduced the limit to 1/20,000,000; lately another pupil of Eötvös, John Ramer, showed that it was not greater than 1/2,000,000,000. The principal importance of these investigations is, that the gravitational theory of Einstein is based on the same proportionality of the gravitational and inert masses, and this is undoubtedly one of the fundamental laws of nature.

I cannot deal extensively with the investigations of Eötvös on terrestrial magnetism, but I cannot fail to mention his researches on capillarity.

First, he introduced a new method to determine the constant of capillarity. This method is independent of all suppositions concerning the angle between the surface of the liquid and the wall of glass. It may be applied to liquids in sealed glass-bottles at all temperatures up to the boiling point or to the critical-temperature. He ascertained the following law to be valid for liquids which do not dissociate at their boiling point. If α be the constant of capillarity, v the molecular volume, τ the absolute temperature, then:

$$\frac{\alpha}{\alpha\tau}(\alpha v^{2/3}) = 0{,}22 \text{ F } (0{\cdot}227)/$$

or, integrated,

$$\alpha v^{2/3} = \mathrm{K}\,(\tau' - \tau)$$

τ' is that characteristic temperature of the liquid at which α disappears. Later Madelung and especially Born and Courant undertook theoretical investigations concerning the law of Eötvös and they found that the quantity K in conformity with experience is but minutely inconstant and may be expressed by the following formula:

$$\mathrm{K} = 0{,}210\,\left(1 + \frac{\theta}{3\tau}\right)$$

where θ is the critical temperature occurring in Debye's theory of solids.

I may say that Eötvös influenced the scientific life of Hungary most effectively not only with his important discoveries but also with his noble personality.

The greatest interest in the field of physical science in Hungary was taken in optics. First I have to mention I. Fröhlich who, with the result of the strenuous work of forty years, laid down the real foundation of Hungarian optical research. His investigations deal especially with the polarisation of diffracted light. He published his researches in a book written in German. He succeeded in proving with absolute certainty the penetration of light into the optically lighter material in the case of total reflexion. In connection with these investigations we have to mention the researches of P. Selényi, and the investigations on fluorescence of I. Fröhlich.

I. Fröhlich constructed further an instrument for measuring the intensity of an electric current on the basis of the electrodynamometer principle, and made also careful investigations to estimate the absolute electric resistance.

S. Rybár whose gravitational balance I have already mentioned, got a good result demonstrating the absolute value of the alteration in the phase of light in the case of total reflexion.

S. Rybár investigated further the Zeeman effect of Lanthanum and Cobalt, he also made valuable researches about the alteration of the constant of capillarity with temperature till the critical point of some liquids and found it in agreement with the formula of Eötvös.

The optical researches of B. Pogány deserve special attention with regard to the theory of relativity; he carefully repeated the Saquæ experiment at Zeiss's in Jéna. He established a big physical laboratory at the Technical University in Budapest. Here many band-spectra researches are conducted under the guidance

of R. Schmid with the assistance of many others. Many researches came out from that splendidly equipped Institute: *e.g.*, The correct separation of several bands, the determination of their Zeeman-effect, the energy of linkage in some carbonates, etc. There is an interesting instrument, an electromagnet with wedge-shaped poles of the length of 60 cm.: with its help it was possible to determine the Zeeman-effect of slightly absorbing materials, such as oxygen (O_2).

One of the most prominent pupils of Eötvös, who also works on gravity and capillarity, Ch. Tangl, has carried out important investigations concerning the dielectric constant. He investigated the change of the dielectric constant of gases resulting from the change of temperature and pressure. The writer of these pages investigated also the change of the dielectric constant of some liquids put under great pressure. Szalay investigated the change of the D. C. with regard to the dipole-theory of Debye.

In the last few years in Prof. Tangl's Institute in connection with the investigations of Miss Forró about the cosmical radiation a grand experimental arrangement was made. Later Barnóthy perfected the method. Now the device registers automatically the number of electrons which pass through both counters at an interval less than 10^{-5} second, but does not register electrons reaching the different counters at a longer interval. They went into the study of the question whether there is any periodicity about cosmic rays; last summer they explored the absorption of cosmic rays in the coal-mines at Dorog (Hungary) and found that the depth of 1,400 meters of water-equivalent was the noticeable limit of the penetration of cosmical rays.

Among other investigations I may mention the researches of Z. Gyulai about the photoelectric effect of selenium and salt and about their electrical conduction under the influence of light and his investigations about the process of crystallisation; Náray-Szabó determined the structure of some crystals by the method of Bragg; Szalay studied the dielectric constant and the ultrasonics. I call special attention to the investigations of G. Békéssy about the mechanism of hearing and some other problems of acoustics of technical importance, which are highly appreciated.

Everywhere in the world, the laboratories of the big factories are of growing importance not only for technical, but also for proper physical research. Also in the laboratories of the "Egyesült Izzólámpagyár" and "Vatea," two well-known factories for electric bulbs and radio valves, some important researches of purely scientific character are being made. Z. Bay, Director of the Research Laboratory of E. I., former Professor at the University of Szeged, analysed the electric discharge in rarefied gases and now he deals with the destruction of the nucleus. P. Selényi worked out a method for electrostatical registration.

In the laboratories of the "Vatea" factory Director Patay with the help of some others investigates high-emitting hot cathodes and physical problems connected therewith.

Theoretical physics has been of great interest since a long time in Hungary: first have been dealt with mechanics (Réthy, Konig), technical mechanics (K. Szily jr., Rejtö), and then the problem of the mechanical interpretation of the second law of thermodynamics (Réthy, K. Szily sr.).

A prominent personality in theoretical physics was T. Farkas. A scientist of strong mathematical mentality he was mainly concerned with the problems of mechanics, thermodynamics and electrodynamics. He was a very consistent representative of phenomenologism which is strongly connected with the names of Kirchhoff, Dham and Voigt. His best result was the interpretation of the principle of virtual displacement in the form characterised by Fourier by means of an inequality. He very carefully investigated the importance and the limit of validity of the principle and applied it to some problems in mechanics and thermodynamics. Dealing with the mathematical bases of the principle he was obliged to investigate the theory of linear inequalities and doing so he discovered the chief theorems of it independently though at the same time as Minkowski.

His investigations concerning thermodynamical equilibrium are of great importance, he expressed the second law of thermodynamics in a general formula, which is nearly the same as the celebrated formula given by Caratheodory fourteen years later.

Besides, Farkas dealt with pure mathematical problems too: with the principle of Huygens, he gave a continuum theory of electricity and was one of the first who appreciated the significance of the theory of relativity of Einstein.

In theoretical as in experimental physics some good investigations were made by V. Zemplén. He has done important researches to determine the internal friction of gases with the help of pendulating and rotating globes, and carried out investigations about some theoretical questions in mechanics, kinetic theory of gases and hydrodynamics.

Another student of theoretical physics E. Bródy worked for a long time with M. Born, together with whom he published several papers. I want to mention his work concerning the quantification of oscillations with finite amplitude and his researches about the chemical constant, band spectra, especially that of the NO molecule, and finally his investigations concerning the linkage of carbon atoms.

E. Császár dealt with the radiation of a black body and with other problems of quantum theory and recently with the absorption of X-rays.

K. Széll dealt with the entropy of gases in different cases.

(To be continued.)

RESEARCH ITEMS.

On a Characteristic Property of Trigonometrical Polynomials.—Markoff (*Comp. Math.*, **3**, Fasc. 3, 305-309) has proved the following theorem about periodic continuous functions. Let $f(x)$ be a function with period 1 (and continuous). Then only the following two cases are possible: either the sum $\sum_{k=1}^{n} f(k\alpha)$ considered as a function of n is bounded for every irrational α, or the set of values of α for which the sum is bounded form a set of the first catagory; and if the first case is ture, then

$$f(x) = \sum_{-N}^{N} a_k e^{2\pi kix} \text{ with } a_0 = 0$$

and in the second case no such representation is possible. The proof is elementary and is brought about by a series of lemmas of which the following are the leading ones:

Lemma 1. If under the same conditions as above $\left|\sum_{k=1}^{n} f(k\alpha)\right| \leqslant C$ for some irrational α, then $\left|\sum_{k=1}^{n} e^{2\pi mki\alpha} \int_0^1 f(x)\, e^{-2\pi mix}\, dx\right| \leqslant 2C$ and $\int_0^1 f(x)\, dx = 0$. (The latter part follows when we observe that $k\alpha - [k\alpha]$ is uniformly distributed in 0, 1.)

Lemma 2. Under the same conditions

$$\left|\frac{1}{1 - e^{-2\pi mi\alpha}} \int_0^1 f(x) e^{-2\pi mix}\, dx\right| \leqslant 2C$$

and

Lemma 3. If under the same hypothesis $\int_0^1 f(x)\, e^{-2\pi kix}\, dx \neq 0$ for an ∞ of k's, then the set of values of α for which the sum is bounded is of the first category. With the proofs of these three lemmas the theorem follows.

K. V. I.

Development of the Male Gametes in Angiosperms.—Poddubnaja-Arnoldi (*Planta*, 1936, **25**, 502–529) studied the development of the male gametes in some angiosperms with a view to find an answer to the following questions: (*a*) whether the male gametes are merely naked nuclei or cells, (*b*) whether the vegetative nucleus persists or undergoes an early degeneration (thus being of importance for the growth of the pollen tube or not) and (*c*) whether the nuclei in the tube have an independent movement of their own, or are merely carried passively by the streaming of the vegetative plasm? These questions are of considerable importance and it is, therefore, necessary to consider Mrs. Poddubnaja-Arnoldi's conclusions rather critically.

She describes sperm *nuclei* (and for most of these species also a naked generative nucleus) in *Cannabis sativa* L., *Aconitum lycoctonum* L., *Papaver somniferum* L., *Crepis capillaris* (L.) Wallr., *Taraxacum koh-saghyz* Rod., *Allium cepa* L., and *Secale cereale* L. No mention is made of the investigations of Golinski (1893) and Osterwalder (1898), who, contrary to her own observations) had seen sperm *cells* in *Secale cereale* and *Aconitum napellus*! She herself admits, however, that it is very difficult to obtain a good fixation for the male gametophyte and the reviewer can say from his own experience that the aceto-carmine method, which she preferred to use for the most part, may have led her to erroneous conclusions.

The same thing must be said with regard to her statement about the degeneration of the vegetative nucleus. It must be emphasised that only the Feulgen reaction can enable definite conclusions on the question whether the vegetative nucleus has degenerated or is still present. It may be admitted, however, that the vegetative nucleus does not now appear to be so extremely necessary for a normal germination of the pollen grains, as was thought before. As to its movement the author supposes that it is a passive one.

Generative and sperm cells are described in two species, *Pisum sativum* L., and *Nicotiana rustica* L. Pollen of these species as well as of *Secale cereale* was treated with X-rays (1000–80,000 "*r*"). At lower radiation forces the generative nuclei divide irregularly and form "Mikrospermien" or take a bicuit-like shape. At higher radiation forces the division does not take place at all and the generative nucleus shows a homogeneous or otherwise changed structure. Due to their incapability for division the author concludes that the generative nuclei are killed in these cases. The protoplasm, however, seemed to have remained unaffected by the radiation, since the tubes were still growing quite normally. Though killed by the radiation (if we are to accept the opinion of the author), the generative cells of *Pisum* and *Nicotiana* and the sperm cells (Golinski :) of *Secale* were able to enter the pollen tube. From this it is inferred that the male gametes have no independent power of movement but are carried along passively.

To this conclusion must be raised the following objections: (1) the author only showed that the generative nuclei do not divide after radiation and not that they were necessarily dead, and that (2) an active movement of the generative cell would really depend far more on the activity of its plasm than of the nucleus within it. The author herself shows that the vegetative plasm behaves quite normally after radiation and it would seem reasonable to conclude that the same is the case with the generative plasm. Just for that reason alone, it would seem possible that the generative cells continue to move independently in spite of the changed (not killed !) nuclei. Even if we were to admit that the generative or sperm nuclei are naked, the possibility of their being able to move independently cannot be denied, for the author only proved

their incapability to divide; it does not necessarily follow that they also lost their power of movement and had to be carried by the streaming of the vegetative plasm!

H. D. WULFF.

The Influence of Moonlight on the Activity of Certain Nocturnal Insects, particularly of the Family Noctuidae, as indicated by a Light Trap.—Since he came over to Rothamstead from Edinburgh in 1932, Dr. Williams has been chiefly engaged in studying insect activity in relation to climatic and weather conditions. His method of insect collection has been by means of a light trap, redescribed by him recently in its improved form (*Trans. Roy. Ent. Soc.*, 1935) its chief feature being a clockwork arrangement by which the time of entry of an insect into the trap can be estimated. The captures made by this trap were used to test the popular belief that insect activity, at least in certain groups, particularly Lepidoptera, decreases on moon-lit nights, this decrease being especially noticeable in those insects that are attracted to light. (Williams, *Phil. Trans. Roy. Soc., Lond.*, (B), October 1936.)

For this purpose moonlight was measured by a photographic instrument which produced a line image of the moon by means of a cylindrical lens focussed on to a strip of a sensitive paper. As moonlight is considerably affected by the presence of clouds in the sky this factor was also measured by means of a long focus camera which photographed the pole star and the tracings of its image on a sensitive paper gave a measure of cloudiness each night.

Dr. Williams' finding is that there is a distinct lunar effect on insect captures at night; fewer insects coming to the trap on moon-lit nights than on dark ones. Whether this is due to the fact that a moon-lit night being a clear night is cooler and not many insects are flying about owing to this fall in temperature or that the moonlight is competing with the artificial light of the trap and reducing its efficiency is a point that is not definitely answered in the paper. Dr. Williams inclines to the view that the effect of moonlight is at least partly physiological since it differs in different groups of insects without any reference to their time of flight but promises to settle the point by further work, using a method of insect collection which has not to depend on light as an attraction. Incidentally this will also widen the range of the investigation by making it possible to study the reactions of certain other insects that are not positively phototropic.

K. B. LAL.

Chromosomes of Ant-lions.—In a paper entitled "The chromosomes of six species of Antlions (Neuroptera)" published as contribution No. 106, November 1936, from the Zoological Institute, Faculty of Science, Hokkaido Imperial University, Japan, J. J. Asana and Hisao Kichijo have recorded their investigations on the chromosomes of six species of Neuroptera from India.

Our knowledge of the chromosomes of this interesting group of insects is of very recent growth. In the year 1932 Oguma and Asana[1] published a report on the chromosomes on an Indian species of Palpares. Since then considerable advance has been made by other investigators among whom the work of Naville et de Beaumont[2] has thrown much light on the establishment of systematic relationship of the chromosomes between allied orders. So far as the literature shows, the chromosomes of Neuroptera have been investigated in 33 species covering eight families. All the authors are in agreement that in the species they have studied the male is heterogametic, the male sex cells are of the usual two types, the X- and Y-bearing complexes. Again, the two components of X–Y complex among all these species show a striking uniformity in their behaviour at the time of reduction division. They show a remarkably precocious separation in contrast to the behaviour of the autosoma tetrads at this stage of spermatogenesis in Neuroptera.

The numerical relation between the chromosomes of six species of ant-lions from India is given in the following table:—

Species	Haploid	Diploid	Sex-chrom
(*a*) Myrmeleonidæ—			
1. Myrmecælurus sp. (*M. acerbus* ?) ..	7	14	XY
2. Macronemurus sp. ?	8	16	XY
3. Neuroleon sp.	8	16	XY
4. Myrmeleon sp. (*M. sagax* ?) ..	7	14	XY
(*b*) Ascalaphidæ—			
5. *Ogcogastor segmentator* ..	..	22	XY
6. *Glyptobasis dentifera* ..	..	22	XY

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[1] Oguma, K., and Asana, J. J., *Journ. Fac. Sci. Hokkaido Imp. Univ.*, 1932, Ser. VI, 1.

[2] Naville, A., et de Beaumont, *Arch. d'Anat. Microsc.*, T. 29.

SCIENCE NOTES.

Indian Physical Society.—The Third Annual Meeting of the Indian Physical Society was held at Hyderabad (Deccan) on the 6th January, with Prof. M. N. Saha (President) in the Chair.

The President delivered an address on "Mission of Physicists in India" which was followed by a talk on Cosmic rays.

The following were duly elected office-bearers and members of the Council for 1937:—

President: Prof. M. N. Saha; *Vice-Presidents:* Dr. S. K. Banerjee, Prof. D. M. Bose, Prof. G. R. Paranjpe and Prof. H. P. Waran; *Secretary:* Prof. S. K. Mitra; *Treasurer:* Prof. P. N. Ghosh; *Members of the Council:* Prof. A. C. Banerjee, Prof. S. N. Bose, Dr. B. N. Chuckervatty, Prof. P. K. Datta, Prof. K. Prasad, Dr. K. R. Rao, Prof. B. B. Ray, Prof. N. C. Ray, Principal B. M. Sen, Prof. N. R. Sen, Prof. J. B. Seth and Prof. M. R. Siddiqui.

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Calcutta Mathematical Society.—At the Annual Meeting, held on the 31st January, the following were elected office-bearers and members of the Council for the year 1937:—

President: Professor Syamadas Mukherjee; *Vice-Presidents:* Principal B. M. Sen, The Hon'ble Sir S. M. Sulaiman, Professor C. V. Hanumantha Rao, Dr. N. N. Sen and Professor F. W. Levi; *Treasurer:* Mr. Satis Chandra Ghosh, *Secretary:* Mr. S. K. Chakravarty; *Other Members of the Council:* Professor N. C. Roy, Dr. S. M. Ganguly, Mr. Ramaprosad Mukherjee, Professor N. R. Sen, Professor A. C. Banerjee, Dr. P. L. Srivastava, Dr. M. R. Siddique, Professor N. M. Basu, Dr. C. N. Srinivasiengar, Dr. J. Ghosh, Dr. R. N. Sen and Dr. S. C. Dhar.

* * *

Indian Chemical Society.—At the Thirteenth Annual General Meeting of the Society held on Wednesday, the 6th January, the following were elected office-bearers:—*President*: Prof. J. C. Ghosh; *Hon. Secretary*: Prof. B. C. Guha; *Hon. Treasurer*: Prof. P. Neogi; *Hon. Editors*: Dr. S. S. Joshi, Dr. A. C. Sircar; *Hon. Auditors*: Mr. P. C. Nandi and Mr. T. K. Roy Choudhuri.

The following resolutions of the Fine Chemicals Committee were passed:—"Resolved that a circular be issued by the Hon. Secretary of the Indian Chemical Society to Universities, Colleges and Research Institutes requesting them to send copies of their indents for organic and inorganic chemicals for the last three years with quantities and price."

"Resolved further that a Sub-Committee consisting of the following, with power to co-opt, be appointed to consider the replies received:—Prof. P. C. Mitter (*Convener*), Drs. M. S. Patel, B. C. Guha, H. K. Sen and K. H. Hassan."

* * *

Society of Biological Chemists (India).—The Sixth Annual General Meeting of the Society was held on Wednesday, 6th January 1937, at Hyderabad. Lt.-Col. S. L. Bhatia presided. The Revised Rules were accepted with certain modifications.

The following office-bearers were elected for the year 1937:—

President: Dewan Bahadur Dr. Sir U. N. Brahmachari; *Vice-President:* Dr. Gilbert J. Fowler; *Hon. Secretaries:* Dr. C. N. Acharya, Mr. B. H. Iyer; *Hon. Treasurer:* Dr. V. Subrahmanyan; *Hon. Auditor:* Mr. M. Srinivasan; *Members of the Executive Committee:* Dr. V. N. Patwardhan, Dr. B. C. Guha, Dr. M. Damodaran, Dr. B. N. Iyengar, Mr. N. V. Joshi, Dr. P. E. Lander, Dr. N. R. Dhar, Dr. S. Kasinatha Ayyar, Mr. Y. D. Wad, Dr. H. K. Sen and Dr. T. N. Seth.

A joint meeting of the Physiological Society of India and the Society of Biological Chemists (India) was also held at the same time and place, to consider the desirability of starting an *All-India Journal of Physiology and Biochemistry*. The following resolutions, moved from the Chair, were unanimously accepted:—(1) This joint meeting considers that it is desirable to have a common journal for the Physiological Society of India, the Society of Biological Chemists (India) and the Biochemical Society of Calcutta. (2) A Committee consisting of the following gentlemen be authorised to go fully into all matters connected with the starting and running of such a Journal and to report their conclusions at the next Annual General Meeting of the Societies concerned to be held at Calcutta in January 1938:—Col. Bhatia (*Convener*), Dr. Burridge, Rao Bahadur B. Viswa Nath, Dr. V. Subrahmanyan, Dr. B. C. Guha, Dr. B. Narayana, Mr. Y. D. Wad, Dr. A. S. Paranjpe, Dr. Rahman, Dr. N. M. Basu, Dr. Basheer Ahmed and Dr. C. N. Acharya.

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Association of Economic Biologists.—The Seventh Annual Meeting of the Association of Economic Biologists, Coimbatore, was held on 1st February 1937. The following office-bearers were elected:—

President: Mr. K. Krishnamurthi Rao; *Vice-President:* Dr. J. S. Patel; *Secretary:* Mr. M. C. Cherian.

The retiring President, Mr. V. Ramanatha Ayyar, delivered an address on "Herbaceum Cottons of India".

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Indian Botanical Society.—At the Annual Meeting of the Indian Botanical Society held on Wednesday, the 6th January at Hyderabad, the following office-bearers were elected for 1937–1938:—

President: Dr. B. Sahni; *Vice-Presidents:* Dr. S. R. Bose and Mr. H. G. Champion; *Members of the Council:* Dr. S. P. Agharkar, Dr. Y. Bharadwaja, Mr. K. Biswas, Dr. H. Chaudhuri, Prof. R. H. Dastur, Dr. T. Ekambaram, Dr. S. L. Ghose, Dr. K. C. Mehta, Prof. J. H. Mitter and Prof. P. Parija.

A Sub-Committee consisting of the following botanists was formed to consider the suggestion by the International Commission on Agricultural Meteorology, for a scheme for recording phenological observation in India:—

Dr. S. P. Agharkar, Mr. H. G. Champion, Prof. A. C. Joshi, Prof. M. Sayeeduddin, Dr.

M. O. P. Iyengar, Prof. P. Parija, Dr. R. R. Stewart, Dr. K. Biswas, Dr. E. K. Janaki Ammal. Dr. C. D. Darlington, Cytologist, John Innes Horticultural Institution, Merton, England, was unanimously elected an Honorary Member of the Indian Botanical Society.

* * *

Index to Geological Literature Available in Bangalore.—The *Central College Geological Society* has just started the publication of a monthly Index to the geological literature available in Bangalore, the need for which has been increasingly felt within recent years by the increasing number of those engaged here in geological research. Between the Central College, Mysore Geological Department, and the Indian Institute of Science, nearly 30 journals and periodicals relating to Geology are received, and the proposed Index is a compilation wherein all the papers appearing in these journals will be properly classified in a form suitable for readers' reference. The number for January 1937 which has just been issued, speaks for itself about the value and usefulness of such a compilation.

* * *

Measurement of the Non-skid Properties of Road Surfaces.—(His Majesty's Stationery Office. Price 9*d.*) The provision and maintenance of non-skid road surfaces is a matter of vital concern to road users and has received great attention in the past few years from road makers. A means of measuring the slipperiness of a road surface is provided by the motor-cycle and sidecar apparatus, which has been in regular use for a number of years. The apparatus and its method of operation are described in Road Research Bulletin No. 1.

* * *

Studies in Road Friction—1. Road Surface Resistance to Skidding.—(His Majesty's Stationery Office. Price 1*s.* 6*d.*)—The results and conclusions drawn from the large number of tests made with the above apparatus are given in Road Research Technical Paper No. 1.

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The National Academy of Sciences (U.P.).—We have pleasure in congratulating Prof. B. Sahni, D.SC., SC.D., F.A.S.B., F.G.S., F.R.S., Head of the Department of Botany, University of Lucknow, on his recent election as President of the National Academy of Sciences. Prof. Sahni's eminence in the scientific world is a source of pride to all who know him and his achievements have raised the prestige of this country as a competitor in producing new knowledge. We have no doubt that under his inspiring guidance, the National Academy of Sciences, which already occupies an important position and fulfils a great purpose, will add fresh lustre to its distinguished record.

* * *

Dr. K. S. Krishnan, Mahendralal Sircar Professor of Physics at the Indian Association for the Cultivation of Science, is proceeding to England shortly. He has been invited to deliver a course of lectures on the physics of crystals at Cambridge and other Universities in England and on the Continent.

Much of Professor Krishnan's earlier work was carried out at the Indian Association for the Cultivation of Science in collaboration with Prof. Sir C. V. Raman, F.R.S., N.L. During the last few years Prof. Krishnan has carried out valuable researches on the magnetic properties of crystals, and has contributed a series of memoirs on this subject which have been published in the *Transactions of the Royal Society*. He was invited to attend the International Conference on Photoluminiscence held at Warsaw a few months ago.

Professor Krishnan's recent work relates to the study of properties of crystals in the neighbourhood of absolute zero temperature.

* * *

Professor Bailey Willis in Bangalore.—Professor Bailey Willis, Emeritus Professor of Geology, Stanford University, California, U.S.A., who is on a world tour paid a short visit to Bangalore during the latter half of January. *The Central College Geological Society* took advantage of his brief stay here and invited him for a social evening and to address the members. Professor Willis is a great traveller, a geologist of international reputation, and author of numerous papers on tectonics and general geology.

After a group photograph and tea, an assembly was held. The distinguished guest was introduced by Prof. L. Rama Rao. Professor Willis then addressed the meeting on "The Crust of the Earth". The Lecturer said that it was no longer possible to believe that the crust was a thin hard layer which was formed by the cooling of a molten globe. Recent evidences show that the earth is solid and rigid practically to the core. The key to this problem was to be found in radioactivity. Radioactive elements were not distributed uniformly but sporadically in the interior of the earth, and by their disintegration enough heat was produced in certain localities to cause melting of the rocks. Differentiation took place in these rock magmas which were extruded at various periods in the history of the earth and gave rise to the crust. After the lecture, several members asked him questions to which he gave suitable replies, drawing mostly from his wide experience of different lands, acquired during his travels.

* * *

Dewan Bahdur Dr. L. K. Ananthakrishna Iyer, B.A., M.D. Hon. (Bres.), one of the foremost anthropologists in India, whose work has brought him quite a large number of honours, has recently been elected an Honorary Member of the Scottish Anthropological Society, Edinburgh. We have pleasure in offering him our cordial felicitations. We wish him a long life of uninterrupted health and prosperity.

* * *

Imperial Economic Committee: Vegetable Oils and Oilseeds.—The Imperial Economic Committee, in a statistical review of world production and trade entitled "*Vegetable Oils and Oilseeds*", points out that the consumption of fatty oils of vegetable origin has developed enormously with the increased demand for fats, although animal products, *i.e.*, butter, lard and tallow,

remain the principle individual fats of commerce. The seeds and nuts of many different plants and trees can be made to yield oil, the review deals with those of chief commercial importance.

According to a press note issued by the Director of Public Instruction, the British Empire, particularly in India and the Colonies, is an important producer of vegetable oils and oilseeds, and many parts of the Empire carry on a considerable export trade. On balance, the Empire has a substantial net export for many of the oilseeds and nuts, notably groundnuts, palm kernels and copra. There is, however, a large net import into the Empire of cottonseed, linseed and soya beans.

Cottonseed.—Cottonseed is an important source of income to the cotton farmer. Almost the entire output in the United States, which is by far the largest producer, is consumed at home and exports from India, the second largest producer, have been negligible in recent years. Egypt, the Anglo-Egyptian Sudan and Uganda are the principal exporters of cottonseed, while there are only two large importers, the United Kingdom and Japan.

Linseed.—Argentina, the largest producer of linseed accounts for over four-fifths of the world exports. India and Uruguay are next in importance. Imports into the United Kingdom come almost entirely from Argentina and India and since 1933 the latter has been the chief supplier except in 1935.

Groundnuts.—India and China are the principal producers of groundnuts, but both retain a large part of their production. Senegal, Nigeria and the Gambia, on the other hand, export the greater part of their output. France, the first European country to import groundnuts, still maintains its place as the leading importer.

Copra.—The largest exporters of copra are the Netherlands, East Indies and the Philippines, the latter also shipping large quantities of cocoanut oil. Exports from Empire countries amount to roughly one-third of the world total. British Malaya and Ceylon are the chief Empire exporters, but the trade is of the greatest importance to Fiji, accounting for about 13 per cent. of the value of all domestic exports between 1931 and 1935. Imports into the United Kingdom, which have tended to increase, are now shipped entirely from the Empire.

* * *

Survey of India.—During the year 1936, for which the report has just been published, the Survey of India completed the survey of 57,036 square miles, of which 3,987 square miles were areas previously surveyed in the more thickly populated districts and now brought up to date. Original survey was completed in 53,049 square miles on various scales, thus completing for India a total of 1,304,453 square miles of modern survey, leaving 580,187 square miles yet to be surveyed (according to a press note issued by the Director of Public Information, 2nd February 1937).

The methods used were mainly triangulation or traverse frame work, with the details filled in by plane table, or in some cases surveys from air photographs.

Various large-scale city and cantonment surveys were also carried out, the most notable amongst which was the combined air and ground survey of Nagpur in the Central Provinces.

Though the primary duties of the Survey of India are geodetic, topographical and geographical, the Department is also developing co-operation with local survey agencies with a view to mutual economy and is now doing a considerable amount of miscellaneous outside work on payment, besides advising and assisting the Provincial Governments with local and settlement surveys as required.

A special party, it may be mentioned, was formed in October 1935, to assist the Sino-Burmese Boundary Commission.

The work of the Department during 1936 has not been without adventure. A party penetrated the " Inner Sanctuary " of Nanda Devi, of which they made a photographic survey under very arduous conditions. A surveyor and his party were almost overwhelmed by a severe snow-storm in the upper reaches of the Gangotri Glacier in Tehri-Garhwal, and narrowly escaped with their lives. Surveyors accompanied the Visser Expedition to the Karokoram in 1935 which returned to India shortly after the opening of the present survey year, with satisfactory results, and a surveyor is still with Sir Aurel Stein on his archæological expedition to Iran. And it goes without saying that in portions of the area under regular survey, elephants, tigers and panthers were numerous and gave the alarmed surveyors some uneasy moments.

* * *

The Pasteur Institute, Coonoor.—The annual report of the Institute for the year ending 31st December 1935 shows that during the year covered by the report there were no deaths from hydrophobia among those treated at the Institute. This is the third time in the history of the Institute that no death has been reported. 433 patients underwent full treatment and 102, incomplete treatment during the year. The Paris Fixed Virus was in use throughout the year for the preparation of the vaccine and was in its 958th passage at the close of the year. 14,084 courses of antirabic vaccine were issued to the out-centres and the several centres returned 12,282 case cards as completely treated and 2,218 cards as incompletely treated. The total number of deaths from hydrophobia was 20, giving a mortality rate of 0.16 per cent. A total of 12,05,320 c.c. of the antirabic vaccine was prepared during the year. 10 research papers dealing mainly with the studies pertaining to the nutrition of Indian foodstuffs, were published during the year under review.

* * *

The Institute of Brewing.—To celebrate the Silver Jubilee of the foundation of the *Laboratory Club*, which developed into the *Institute of Brewing*, the Council of the Institute decided to issue in November 1936, a Special Number of the Journal of the Institute of Brewing " Containing memoirs by eminent and experienced men, on the progress made in the malting and brewing during the last five decades". As far back as 1876, a group of enthusiasts, among whom may be mentioned

Cornelius O'Sullivan, Adrian Brown and others, inaugurated an informal dining club, the "Bacterium Club" to meet to discuss new discoveries in bacteriology and chemistry relevant to brewing. As the importance of chemical and biological aspects of malting came to be increasingly realised, and the need for the control and analysis of materials and products became compelling, chemists who had a knowledge of brewing started classes in their laboratories to provide instruction on the principles of brewing. Dr. E. R. Moritz, a prominent chemist of the time, realising the importance of discussions and exchange of information and experience between those having aims in common founded in 1886 the *Laboratory Club*. The papers read at the meeting of the Club were recorded in the *Transactions of the Laboratory Club*, the forerunner of the *Journal of the Institute of Brewing*, which is a systematic and continuous record of the labours of numerous investigators interested in the science and practice of brewing. Dr. A. R. Ling was the first editor of the journal.

The Special Number contains nine memoirs covering 54 pages, includes such subjects as, 'Advances made during the last 50 years in malting,' by H. M. Lancaster; 'Advances in the knowledge of malt conversion during the last 50 years,' by Prof. Arthur R. Ling; 'Development of our knowledge of the chemistry of alcoholic fermentation during the last 50 years,' by Sir Arthur Harden; 'Progress in brewery Fermentation during the last 50 years,' by Lloyd Hind; 'Advances made in Brewing, the dietetic value of beer and the by-products of brewing during the last 50 years,' by R. H. Hopkins. The Jubilee Number will be warmly welcomed by all those interested in the progress of fermentation research.

* * *

Research and Progress.—The first number of the Third Volume of this Journal has recently been received. Up to the present, the *Review* was being published as a quarterly. As the Editors have found it difficult to keep up a sufficiently topical commentary on German scientific progress, they have decided to issue it as a two-monthly, hereafter. The price of the single copy will be R.M. 1.50: postage extra. The annual subscription, for the six issues, is R.M. 6.

All enquiries regarding the Journal may be made to the Editorial Office, Unter den Linden 8, Berlin N.W. 7.

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In a previous number of this Journal a short account of the National Geographic Society-Smithsonian Institution **East Indies Expedition,** was published. (Jan. 1937, page 403.) It is now understood that Dr. Mann who leads the expedition, plans to collect, not only rare species of animals and reptiles from the island of Sumatra and other far-away corners of the East for the National Zoological Park in Washington, but he will take with him American animals, which, though common in zoos of that country, are little known in the Far East. It is, perhaps, the first time that an animal-collecting expedition ever started out from America with a good-sized menagerie "in its baggage".

Among Dr. Mann's animal globe-trotters will be oposums, raccoons, mountain lions, jaguars and possibly a black bear or two. Familiar to the eyes of American zoo-goers, these animals are as unusual in the Far East as tigers or aardvarks are in the United States.

Dr. Mann will present the American animals as gifts to zoos in various cities which he expects to visit on the Orient. The gifts will cause no depletion of American zoos, for there is a surplus of these animals in that country.

* * *

Announcements.

International Congress of Psychology.—Owing to conditions in Spain, the eleventh *International Congress of Psychology* which was to have been held in Madrid will be held in Paris. So far as possible, the programme will be the same as that previously arranged for the proposed meeting in Madrid. The Paris Congress will be held on July 25–31, under the presidency of Prof. Pierre Janet, formerly Professor of Psychology in the College de France. Further information can be obtained from M. Henri Pieron, Laboratoire de Psychologie de la Sorbonne, Paris 5. (*Nature*, 1937, January 2.)

* * *

International Congress on Testing Materials.—The next International Congress of the International Association for Testing Materials will be held in London on April 19–24, under the presidency of Sir William Bragg. More than two hundred papers are promised from authorities in twenty different countries. The Congress will be divided into the following groups: metals (behaviour of metals as dependent upon temperature, particularly in regard to high temperatures; progress of metallography; light metals and their alloys; wear and machinability); inorganic materials (concrete and reinforced concrete) erosion and corrosion of natural and artificial stone; ceramic materials); organic materials (textiles; wood cellulose; timber preservation, ageing of organic materials; colours and varnishes); subjects of general importance (relation between results of laboratory tests and behaviour in use and service; bearing of recent advances in physics and chemistry on the knowledge of materials; properties of materials for the thermal and acoustic insulation buildings).

Further information can be obtained from the Honorary Secretary of the Congress, K. Headlam-Morley, 28, Victoria Street, London, S. W.—(*Nature*, 1937, January 2.)

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It is announced that the **International Congress of Genetics** which should have been held in Moscow, U. S. S. R., during 1937, has been postponed on the request of a number of scientists who desired more time for preparation for the Congress. The only purpose of this postponement is the desire to assure the best preparation and the most extensive participation of scientists from various countries.

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We acknowledge with thanks receipt of the following:—

" Journal of Agricultural Research," Vol. 53, Nos. 7 and 8.
" Indian Journal of Agricultural Science," Vol. VI, Part VI, December 1936.
" Monthly Bulletin of Agricultural Science and Practice," Vol. 27, No. 11, November 1936.
" The Philippine Agriculturist," Vol. 25, No. 8.
" Journal of the Royal Society of Arts," Vol. LXXXIV, Nos. 4389–4391.
" Biochemical Journal," Vol. 30, No. 12, December 1936.
" Biological Reviews," Vol. 12, No. 1, January 1937.
" Communications from the Boyce Thomson Institute," Vol. 8, No. 4.
" Journal of the Institute of Brewing," Vol. XLIII, No. 1, January 1937, and Index to Vol. XLII.
" The Calcutta Review," Vol. 62, No. 1.
" Chemical Age," Vol. 35, No. 913, Vol. 36, Nos. 914–916.
" Journal of Chemical Physics," Vol. 5, No. 1, January 1937.
" Journal of the Indian Chemical Society," Vol. 13, No. 10, October 1936.
" Berichte der Deutschen Chemischen Gesellschaft," Vol. 69, No. 13; Vol. 70, No. 1.
" Russian Journal of General Chemistry," Vol. VI, Nos. 9–11.
" Journal de Chimie Physique," Vol. 33, No. 12.
" Experiment Station Record," Vol. 75, No. 6.
" Indian Forester," Vol. LXIII, No. 2.
" Forschungen und Fortschritte," Vol. 13, Nos. 1–3.
Government of India Publications:—
" Indian Trade Journal," Vol. CXXXIII, Nos. 1595–1597.
"Publications of the University of Illinois," Nos. 23, 24, 31 and 32.
Publications of the League of Nations—"Quarterly Bulletin of the Health Organization," Special Number and Vol. V, No. 4.
" Indian Journal of Medical Research," Vol. XXIV, No. 3, January 1937.
" The Calcutta Medical Journal," **32**, No. 1.
" The Punjab Irrigation Research Institute—Report for the year ending April 1936."
" The Pasteur Institute of Southern India—Annual Report of the Director for the year ending 31st December 1935."
"University of Cambridge, School of Agriculture, Memoirs" No. 8, 1936.
"Scientific Reports of the Imperial Council of Agricultural Research, Pusa," 1934–35.
" Journal of the American Museum of Natural History," Vol. 38, No. 5, December 1936.
" Nature," Vol. 138, No. 3504, Vol. 139, Nos. 3505–07.
" Journal of Nutrition," Vol. 12, No. 6, December 1936.
" Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science," Vol. X, Part VI.
" Canadian Journal of Research," **14**, No. 12.
" Ceylon Journal of Science," Section A, Botany, Vol. XII, Part II.
" Science and Culture," Vol. II, No. 8.
" Science Progress," Vol. XXI, No. 123.
" Indian Journal of Venereal Diseases," Vol. 2, No. 4, December 1936.
" Indian Journal of Veterinary Science and Animal Husbandry," Vol. VI, Part IV.
" Arkiv fur Zoologie," Vol. 28, No. 4, 1936.

Catalogues:

" Mitteilungen uber Neuerscheinungen und Fortsetzungen," 1937, No. 1 (Verlag von Gustav Fischer, Jena).
Cambridge University Press, Spring and Summer Books.

ACADEMIES AND SOCIETIES.

Indian Academy of Sciences:

January 1937. SECTION A.—I. CHOWLA: *On Waring's Problem for Cubes.* S. BHAGAVANTAM AND A. VEERABHADRA RAO: *Raman Spectrum of Benzene Vapour.*—The Raman Spectra of benzene in the liquid and vapour states have been photographed alongside each other under identical conditions. When judged by comparing with the 992 line, there is found a very considerable fall in the absolute intensity of the wings as we pass from the vapour to the liquid. B. R. SETH: *On the Flexure of a Hollow Shaft—II.* V. V. NARLIKAR: *A Note on the Mixed Tensor $T\mu^{\nu}$.* S. L. MALURKAR AND M. P. SRIVASTAVA: *On the Differential Equation of the Instability of a Thin Layer of Fluid Heated From Below.* S. CHOWLA: *A Theorem of Erdös.* I. CHOWLA: *On the Number of Solutions of Some Congruences in Two Variables.* L. A. RAMDAS, B. N. SREENIVASIAH AND P. K. RAMAN: *Variation in the Nocturnal Radiation from the Sky with Zenith Distance and with Time during the Night.*—The observations show that the nocturnal cooling of the radiating air layers as shown by the decrease in the equivalent black body temperature of the sky is maximum for the horizontal and minimum for altitude 90°. B. S. MADHAVA RAO: *On the Fine Structure of the Balmer Lines.*—If we lay aside the Born-Schrödinger Radius for the electron as untenable, we can conclude that the interaction of the electron and radiation field does not materially effect the energy levels. R. VAIDYANATHASWAMY: *A Remarkable Property of the Integers Mod N, and Its Bearing on Group-Theory.* R. ANANTHAKRISHNAN: *The Raman Spectra of Crystal Powders. I.—The Halides and Sulphate of Ammonium. II.—The Chlorides and Sulphates of Hydroxylamine and Hydrazine.*—A new technique has been developed using a pair of complementary filters. It is found that when the co-valency of nitrogen changes from three to four, there is a definite lowering of the N-H frequency, and therefore a weakening of the N-H bond. R. S. KRISHNAN: *Dispersion of Depolarisation of Light-Scattering in Colloids. Part I.—Gold Sols.*—In the region of the characteristic absorption the depolarisation factors show an enormous increase. By applying Gan's theory it is inferred that the particles in the gold sols behave optically like elongated ellipsoids with axial ratio equal to about 0.75,

January 1937. SECTION B.—G. N. RANGASWAMI AYYANGAR, M. A. SANKARA AYYAR AND V. PANDURANGA RAO: *Linkage between Purple Leaf-Sheath Colour and Juiciness of Stalk in Sorghum.*—In sorghum there is a linkage between the factor P for purple leaf-sheath colour and D for juiciness of stalk, with a recombination percentage of 30 ± 1.8. G. N. RANGASWAMI AYYANGAR, V. PANDURANGA RAO, A. KUNHIKORAN NAMBIAR AND B. W. X. PONNAIAH: *The Occurrence and Inheritance of Waxy Bloom on Sorghum.*—The heavy bloomed condition (H) is a simple dominant to the sparse bloomed condition (h). The factor (H) is independent in inheritance to the leaf-sheath colour factors P and Q, leaf margin disposition factor $M\mu$, grain surface structure factor Z, and the brown grain factors B_1 and B_2. S. C. DIXIT: *The Chlorophyceæ of the Bombay Presidency, India—I.* Thirty-six forms have been described, out of which four have been found growing in soil, three on stones and rocks, one on a gastropod shell, four in running water and the rest from the steady waters of pools, tanks and ponds. M. B. MIRZA AND M. A. BASIR: *A Report on the Guinea-Worm found in* Varanus *Sp., with a Short Note on* Dracunculus medinensis.—*Dracunculus* is recorded for the first time as a parasite of *Varanus.* The structure of the worm has been compared with that of *Dracunculus medinensis* and it is concluded that it is the same worm which parasitizes the human beings.

Indian Association for the Cultivation of Science: (*Proceedings, Vol. XIX, Part 6.*)

December 1936.—G. N. BHATTACHARYYA: *Studies on Some Indian Vegetable Oils.* JAI KISSEN AND N. K. SAHA: *On the Laws of Distribution of Velocities of Particles undergoing Emission and Absorption in Radiation-Field.* SURAIN SINGH SIDHU: *The L-Spectra of Iron above the Curie Point.* M. K. SEN: *The Band Spectrum of Gallium Oxide and Isotopes Effect of Gallium.* C. J. PHILLIPS: *The Raman Spectra and the Latent Heat of Fusion of Non-Associated Substances.* P. N. KALIA: *Technique of making Schumann-Plates; and A note on the Spectrum of Singly Ionised Zinc.* JAGANNATH GUPTA: *Raman Spectra of Oxalates and Oxalato-Complexes: Vibrations of Dicarbaxyl.* S. C. SIRKAR AND J. GUPTA: *On the Raman Spectra of Different Modifications of a few Crystals.*

Indian Chemical Society:

October 1936.—PRAFULLA KUMAR PAUL: *On Phthalide Formation.* N. R. DHAR AND CH. I. VARADANAM: *Preparation and Properties of Highly concentrated Sols. Part V.—Stannic Hydroxide Sols.* G. V. JADHAV, S. N. RAO AND N. W. HIRWE: *Derivatives of 1-Hydroxy-2-Naphthoic Acid. Part I.—4-Halogeno-1-Hydroxy-2-Naphthoic Acid and their Derivatives.* MAHADEO PRASAD GUPTA AND SIKHIBHUSHAN DUTT: *The Chemical Examination of* Solanum xanthocarpum, *Schard and Wendel. Part I.—The Constituents of the Oil from the Seeds.* DUHKHAHARAN CHAKRAVARTI AND BHOWANI CHARAN BANERJI: *Synthesis of Coumarins and Chromones from Halogenated and Nitrocresols.* B. N. GHOSH AND S. S. DE: *The Enzymes in Snake Venom. Part II.—Their Action on Native Proteins, on Peptone and on the Activity of Trypsin.* T. P. GHOSE AND S. KRISHNA: *Constituents of the Leaves of* Vitex negundo. (Late) A. N MELDRUM AND C. N. BAMJI: *6-Sulpho-m-cresolic Acid and Related Compounds.* G. V. JADHAV AND S. N. RAO, *Derivatives of 1-Hydroxy-2-Naphthoic Acid. Part II.—4-Halogeno-1-methoxy-2-naphthoic Acids and their Derivatives.* DUHKHAHARAN CHAKRAVARTI AND PHANINDRA NATH BAGCHI: *Synthesis of Coumarins and Chromones from 4-Chloro and 4-Bromo-1-naphthol.* D. G. WALAWALKAR: *A Note on Solid Sugars from Mohuwa Flower Syrup.* NRIPENDRA NATH CHATTERJI: *Phenanthrene from 9-Hydroxyphenanthrene (A Note).*

Calcutta Mathematical Society:

January 15, 1937.—H. LEBESQUE: *Sur certaines expressiones irrationnel es illimitees.* E. T. BELL: *Numerical Functions of the Lattice points of xy......z< n.* C. V. HANUMANTHA RAO: *On an analogue of Gaskin's theorem.* R. R. SHARMA: *On Gaskin's theorem.* J. G. ANANDA: *On the inpolarity of a conic to a circle.* A. MOESSNER: *Numerische Identitaten.*

Meteorological Office Colloquium, Poona:

On 7-12-1936 Sir John Russell, F.R.S., Director, Rothamsted Experimental Station, addressed the Colloquium on 'Meteorology in Relation to Agriculture'.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

University of Mysore:

I. *Academic Council.*—A meeting of the Academic Council was held on the 23rd January 1937. Among the decisions arrived at, mention may be made of the following:—

(1) Introduction of an ordinance regulating the course of study in German for B.Sc. Honours students.

(2) Institution of separate minima for the papers, thesis and *viva voce* in the Master's Degree examination.

(3) Provision for the admission of L.M.P. diploma holders to the M.B.B.S. degree course, under certain conditions.

II. The following Extension Lectures were delivered:—

(*a*) Mr. A. R. Wadia, B.A., Bar-at-Law, Professor of Philosophy, Maharaja's College, on "The Charm of Hindi" in English, at Bangalore.

(*b*) Mr. K. Krishna Iyengar, B.A., Headmaster, National High School, Bangalore, on "Civic Discipline" in Kannada, at Mandya, Mysore and Bangalore.

III. A special lecture on "The Crisis of Contemporary Culture" was delivered at Mysore by Dr. Andrew Krzesinski, Professor of Philosophy, University of Cracow (Poland).

IV. Messrs. C. Narasimha Moorty, M.A., and D. K. Srinivasachar, B.Sc. (Hons.), graduates of this University, headed the list of successful candidates in the recent Mysore Civil Service Examination and were appointed as Probationary Assistant Commissioners.

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